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JUN 25 1940

The "Walking" Dragline is here!

RUSTON — BUCYRUS MONIGHAN

The FIRST "Walking" Dragline to be constructed in Great Britain is now operating successfully in the ironstone mines of the Wellingborough Iron Company, Ltd., a branch of The Stanton Ironworks Co. Ltd.

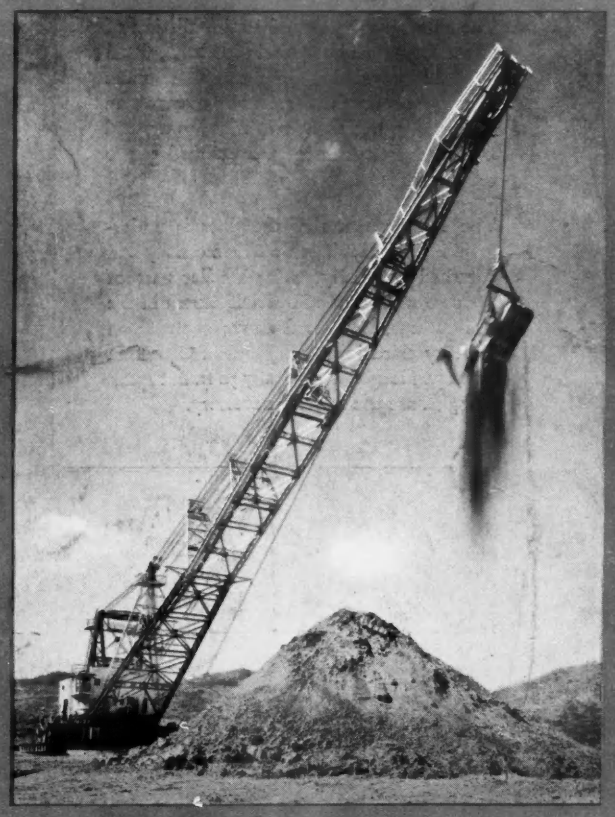
The machine, seen in the above illustration, is an electrically operated Ruston-Bucyrus Monighan so named because it was manufactured by Ruston-Bucyrus Ltd. at Lincoln from the successfully established designs of The Bucyrus-Monighan Company. Hundreds of Bucyrus-Monighan machines are at work in America and various parts of the World.
Two similar machines are under construction at Lincoln, a repeat order for The Stanton Ironworks Co., Ltd., and a diesel-operated machine for The Midland Ironstone Co., Ltd., Scunthorpe.

The unique features of the "Walking" Dragline are :—

The large base, 24 ft. to 36 ft. diameter (depending upon the size of the machine), which enables the dragline to operate on unusually soft ground without the use of timbers.

The ruggedness, simplicity and few wearing parts in the "Walking" mechanism.

The low centre of gravity coupled with the large area of the base which enables longer booms to be fitted than on a "caterpillar" mounted machine of similar weight.



The World's largest Dragline— BUCYRUS MONIGHAN

The "Walking" dragline as illustrated alongside is the largest in the World. Manufactured by Bucyrus-Erie Co., S. Milwaukee, Wis., U.S.A., it is normally supplied with a 20 cubic yard bucket and a 200 ft. boom.

PARTICULARS OF RUSTON-BUCYRUS MONIGHAN and BUCYRUS-MONIGHAN DRAGLINES SENT ON REQUEST

RUSTON-BUCYRUS LTD. EXCAVATOR SPECIALISTS **LINCOLN**

S&L

COKE-OVEN GAS MAINS.

The photographs are of an installation of 'S & L' 14" and 18" steel pipe lines, fitted with sleeve-welded joints. One main conveys crude gas from coke-ovens to an industrial plant some two miles away, and the other main returns the purified gas to the steel works.

The large portion of the lines is underground, the pipes being oiled internally and sheathed externally. The smaller part of the contract, some of which is shown in the illustrations, is erected above ground; on it every third joint is a Johnson Coupling. The span length is normally 30 ft. but spans of 45 ft. are used where necessary.

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A Seven-Day Journal

The Control of Engineering Undertakings

IT was announced by the Minister of Supply, Mr. Herbert Morrison, that under the new Emergency Powers Act an Order in Council issued on Saturday, May 24th, empowers the Minister of Supply to declare undertakings which are, or should be, principally engaged upon war production to be controlled undertakings. This will mean that Ministers of Departments for which war supplies are being produced will have power to prescribe the war work which the firms have to carry out, the hours which they are to work, the labour they are to employ, and the price of the goods. A Minister's directions will over-ride any existing legal or other obligation that may conflict with them. There will also be power to ensure by inspection that directions are carried out. The first list of controlled undertakings is being prepared by the Ministry of Supply in conjunction with the other Departments. It will be issued as soon as possible. Controlled undertakings will, as stated by Mr. Attlee in the House of Commons, be subjected to Excess Profits Tax at the rate of 100 per cent. The Order in Council also provides powers to issue directions and orders to firms other than those on the Controlled List. Firms already engaged upon Government contracts or sub-contracts should continue their work on those contracts with the utmost vigour until any further directions superseding the arrangements under the existing contracts are received. So far as he is concerned, the Minister of Supply intends that the control shall be exercised in such a way that where existing managements are doing their job well and with public spirit and efficiency they will be interfered with as little as possible.

Railway Locomotives and Wagons for France

ON Friday, May 24th, on behalf of the Ministry of Supply, the Director of Transportation Services accepted delivery of the first of a large number of locomotives for use with the British Expeditionary Force now in France. The engines which were handed over are of the standard 2–8–0 L.M.S. and G.W.R. types, which have been specially modified in design to accord with the running conditions in France. These modifications in the design and construction of the locomotives have meant the preparation of new drawings and patterns, and in some cases new tools were required. In accepting delivery, the Director congratulated the chairman of the company which had built the engines on the fact that the new design had been completed in a little more than five months, whereas under normal circumstances from nine to twelve months was required for the production of a new locomotive. It is understood that the delivery of the remainder of the order is to be greatly accelerated. Earlier in the week, as we briefly recorded in last week's issue, the first French trucks, part of an order for 10,000 which has been placed in this country by the Ministry of Supply, of which half are to be constructed by two Midland wagon-building companies, were officially delivered to time. The trucks are of French design and are equipped with Westinghouse brakes, the design being specially suited for fast running. The guests present at the taking over of the trucks included representatives of the Army, the French railways, the Ministry of Supply and the builders. Mr. Peter Bennett, Director-General of Tanks and Transport at the Ministry of Supply, said in the course of a short speech that the Minister, Mr. Herbert Morrison, wished to be associated with the congratulations he offered to the company. The success of that contract was, he thought, a remarkable symbol of Anglo-French co-operation, especially the close working together of the Ministries of Supply in both countries. The sacrifice of the Whitsuntide holiday by all concerned had enabled the manufacturers to give the best deliveries yet achieved.

Germany's Shipping Losses

AN official naval announcement states that within the last ten days or so no less than five German transports and supply ships have been successfully attacked by our naval ships. Other German ships have fallen victims to the Allied minefields. It can now be stated that up to date Germany has lost more shipping through Allied naval action than Britain has lost through German action. The loss which has been sustained by the German mercantile marine is now about 820,000 tons, or one-fifth of its pre-war tonnage. The ships lost by Germany are mostly those which are best suited to keep the German forces in Norway supplied, while the sunken ships include many of a special type designed to bring vital supplies of iron ore from Northern Sweden. While British losses, and general war wastage, have been more than made up by capture, charterings and new construction, that is far from being the case with German mercantile vessels, which have been still further reduced by losses associated with the invasions of Holland and Belgium. Twenty-six German ships, totalling more than 144,000 tons were captured by the Allies when the Germans invaded Holland and Belgium, while two others, totalling more than 10,000 tons scuttled themselves. The attempt to strangle our sea communications, which are vital to Britain's existence, by the attacks made by submarines, mines and aircraft has been checked. The seas are still open to us, meanwhile the German fleet, already barred from most of the seas, continues to shrink. Germany has claimed that she has ceased to be a blockaded power, and that she is in fact now blockading Great Britain. Actual figures show that such a claim is totally untrue. During the first eight months of the war more goods destined for Germany were seized in prize, than Britain lost by Germany's lawless attacks by mine, torpedo and aircraft on neutral as well as Allied shipping. In particular, metals and petroleum, which are especially useful in war, were captured from German shipping in large quantities. Britain's net gain in these two substances alone was well over 140,000 tons.

The T.U.C. Conference

ON Saturday, May 25th, Mr. Bevin, Minister of Labour and National Service, presented to the executives of the whole of the trades unions in a speech lasting for an hour the reasons for the emergency powers with which he has been invested. Two hundred unions were represented by more than a thousand leaders. Mr. W. Holmes, Chairman of the General Council of the Trades Union Congress, which had called the conference, was in the chair. Mr. Bevin described the details of the scheme for the control of industry and of labour, with which the conference registered full agreement. An outline of the scheme is given on page 506. The Prime Minister sent a message stressing the country's needs, which, he said, "were imperative, inescapable and imperious." He added that he had the fullest confidence in the readiness of the organised workers to accept the obligations arising out of the demands which the State was compelled to make upon their endurance and their capacity for sacrifice. He looked with equal confidence to the trades union executives to assist the State by using their widespread organisation. Sir Walter Citrine, General Secretary of the T.U.C., moved a resolution, which was carried with only four dissentients, to the effect that the conference realised the gravity of the dangers inherent in the situation and endorsed the action of the General Council in giving its full support to the necessary measures to protect the people by organising the entire resources of the country; and that the conference expressed its complete confidence in the General Council and its representatives on the consultative committee appointed to advise the Ministry of Labour on all matters arising out of the Emergency Powers (Defence) Act, and other legislation enacted by Parliament. In addition the conference registered a pledge to the fighting Forces that all resources should be employed to provide them with arms and munitions.

Imports of American Machine Tools

ON Monday, May 27th, the Controller of Machine Tools, Ministry of Supply, sent to all Government Departments and importers of machine tools particulars of new arrangements which come into effect on Monday, June 17th, and are designed to co-ordinate United Kingdom demands on United States machine tool builders. The scheme provides that all purchases of new machine tools in the United States of America for British needs will be made by the British Supply Board in Canada and America. Purchases in the United States are to be made on behalf of the Board by the British Purchasing Commission, whose office is at 15, Broad Street, New York City. Purchasers of machine tools will follow normal commercial practice in so far as contracts with agents are concerned. Agents are importers who have been registered under the new scheme at the Machine Tool Control Department of the Ministry of Supply. Such agents will provide purchasers with all necessary advice, including information as to prices, delivery dates and all customary pre-sale and post-sale service. On receipt of an order from a purchaser, the agent will forward the order in duplicate to the British Purchasing Commission. Where a purchaser desires to place an order for machine tools, for which there is no registered agent in the United Kingdom, he proceeds in the same manner as when placing an order with an agent, except that such an order will in the first instance be transmitted by the intending purchaser to the Controller of Machine Tools, Ministry of Supply, and not directly to the British Purchasing Commission. All orders must be sponsored by a Government department, a public utility company, or a local authority. Any agent desiring to be registered under the scheme must submit to the Controller of Machine Tools, Ministry of Supply, 35, Old Queen Street, London, S.W.1, two certified statements of the agency held by him, together with any necessary explanatory notes. The certified statement must indicate whether the agencies mentioned are sole agencies or otherwise.

Appeal for Professional Engineers

THE Ministry of Labour and National Service announces that professional engineers who are enrolled on the Central Register and who are immediately available for national work in their professional capacity are requested to send a postcard to that effect with their name, address and telephone number to the Central Register, Ministry of Labour, Tothill Street, Westminster, S.W.1. This information will be of value to the Minister in making his arrangements for the rapid expansion of engineering production. Further announcements will be made about professional engineers who are not at present registered with the Ministry. Another announcement by the Ministry of Labour states that the response to the recent appeal issued to garage mechanics, &c., to volunteer for work in aircraft factories has been magnificent. It is requested that any worker, and in particular any skilled worker, who wishes to volunteer for urgent war work should notify his nearest employment exchange, and should continue with the work that he is doing until he receives further instructions from the exchange.

Ministry of Aircraft Production Announcements

ON Wednesday, May 22nd, it was officially announced that the Minister of Aircraft Production, Lord Beaverbrook, had appointed two emergency committees, each with full authority, one to deal with the immediate position with regard to air frame production, and the other to deal with alloy steels required for the aircraft and the aero-engine industry. The chairman of the Emergency Committee on air-frame production is Mr. F. S. Spriggs, of the Hawker Siddeley Aircraft Company, Ltd., while the other two members are Mr. C. R. Fairey of the Fairey Aviation Company, Ltd., and Mr. A. Dunbar, of Vickers-Armstrongs, Ltd. The chairman of the Emergency Committee appointed to deal with the immediate position of alloy steels required for the aircraft and aero-engine industry is Mr. A. Matthews, of Thos. Firth and John Brown, Ltd., and Mr. A. B. Winder, of the English Steel Corporation, Ltd., Mr. G. Steel, of Samuel Fox and Co., Ltd., Mr. L. Chapman, of William Jessop and Sons, Ltd., Mr. S. Guy Newton, of Brown Bayley's Steel Works, Ltd., Mr. H. Williams, of Park Gate Iron and Steel Company, Ltd., along with Major E. W. Senior, of the Ministry of Supply, are the other members of the Committee. The Committee has full authority to deal with all questions relating to the supply and the disposition of alloy steels such as are required for the aircraft construction and the aero-engine manufacturing industries.

Women and the War Engineering Industry

ON Wednesday, May 22nd, at a meeting between representatives of the Engineering and Allied Employers' National Federation, the National Union of General and Municipal Workers, and the Transport and General Workers Union, agreement was reached on the question of wages to be paid to women brought temporarily into the engineering industry for the period of the war. The agreement provides that for a probationary period of eight weeks women shall be paid at the women's national schedule time rate and bonus. At the end of that period, and for twelve weeks after it, the basic rate is to be increased by one third of the difference between the women's schedule rate and that of the men they replace, and the bonus increased by one third of the difference between the women's bonus and the men's bonus. After that, for a period of another twelve weeks, the basic rate for women is to be 75 per cent. of the men's rate with 75 per cent. of the men's bonus added. Thereafter, women who require no special supervision will receive the basic rate and the bonus applicable to men. In the case of women who are still under supervision at the end of thirty-two weeks, the rates of payment will be negotiable. Agreement was reached between the employers and the trade unions to allow more women to be brought into the engineering industry for the period of the war. It may be noted that the agreement which was reached embodies the principle of "equal pay for equal work."

Water Supply of Rangoon, Burma

No. I

AT the end of the present year, providing that the monsoon brings the usual plentiful rainfall, it is expected that the Gyobyu reservoir will come into operation. This reservoir, which is being constructed to augment the water supplies of Rangoon in Burma, will have been created by a dam built across a valley in the Pegu Yomas hills which are situated about 40 miles to the north of the city; and its waters will be carried down to the city by gravitation in a pipe line.

The decision to put the work in hand was taken by the Corporation of Rangoon in 1935 and the Pegu Yomas scheme, as it is known, was chosen on the advice of its consulting engineers, Binnie, Deacon, and Gourley of Westminster. At that time Rangoon, the chief city of Lower Burma, had a population of about 400,000 people and derived its water supply from Hlawga Lake, situated a few miles north of the city, and from tube wells. The maximum available supply from the former source averages 12 million gallons per day and is sufficient to meet the needs of about 270,000 people. From the tube wells, which are sunk into permeable strata underlying clay, only another 600,000 to 700,000 gallons per day can be drawn, sufficient for another 40,000 people. Until the new reservoir comes into operation, therefore, no public supply has been, or will be, available for about 90,000 persons.

Rangoon is situated at latitude 15 deg. North and lies in the great Asian monsoon area. The extent to which reservoirs in the neighbourhood must be dependent on the monsoon for their supplies is illustrated by the rainfall figures. Over the 12·9 square miles of virgin forest that form the catchment area of the Gyobyu reservoir the estimated average annual rainfall amounts to 110in. But more than 90 per cent. of this total annual rainfall occurs in the monsoon season, from April to September. Variation in the annual rainfall is small, and there is no recorded instance of a failure of the monsoon since records first began to be kept in 1872.

When completed the new reservoir will have a gross capacity of about 17,000 million gallons, of which about 8500 million gallons will be available for supply to Rangoon. The calculated yield from the catchment area is at the rate of 22⅝ million gallons a day, and the maximum supply available to Rangoon by gravity 20 million gallons per day. Top water level in the reservoir will be 215ft. above datum as compared with the average water level of 135·9ft. above datum in the Kokine service reservoir at Rangoon into which the water will flow.

The main dam which creates the reservoir is situated in a narrow gorge at a point where the river bed swings sharply from a generally south to north direction on to an east to west line. The site is an economical one in relation to the height of the dam and the amount of storage provided. Sandy shales and thin beds of friable sandstone belonging to the Pegu Yomas series of Tertiary age form the strata on which the dam is founded. The intake tower is placed near the southern end of the dam. The overflow weir is situated north of the dam and delivers the excess water over a depression in a ridge which separates the Gyobyu River from a small tributary that enters the main stream about 130 yards below the toe of the main dam.

The complete Pegu Yomas scheme provides for the construction, in addition to the main dam, of a second dam in a nearby valley and the driving of a tunnel through the dividing ridge in order to divert the waters of the Nyaunglebin into the main reservoir. If and when this additional work is carried out the calculated yield will be increased to 25 million gallons per day. But it has not been entered upon for the present.

The site of the main dam lies about 3¾ miles from the village of Taikkyi, through which there passes a main road and a railway from Rangoon. From that village a road was constructed up to the works. It is provided with two reinforced concrete tracks so spaced as to form a runway for motor-lorries. The headworks of the Pegu Yomas scheme are being carried out by administration and no main contractor has been employed. Cement has been obtained from the Burma Portland Cement Works and cast iron valves and other special equipment were supplied by Glenfield and Kennedy, Ltd., and Guest and Chrimes, Ltd.

FIG. 1—UPSTREAM ELEVATION OF DAM

The Main Dam

Two important factors had a predominant influence on the design of dam chosen. An earth embankment was considered preferable to a masonry structure on account of the lesser stresses it would impose on the foundation material. The area in which the dam is situated is liable to be affected by earthquakes and in that respect also it has been the experience of the consulting engineers that an earth embankment is capable of withstanding distortion more successfully than other types of dam. Some years ago one of the partners visited Japan, after the earthquake shock of 1923, and was much impressed by the effects of the shock on a dam creating a reservoir for the supply of Tokyo. This dam consisted of an embankment with a clay puddle core, and although it had been so distorted that, though originally straight, it had assumed an "S" shape, it had still remained tight. Masonry structures subjected to the same conditions had been severely cracked.

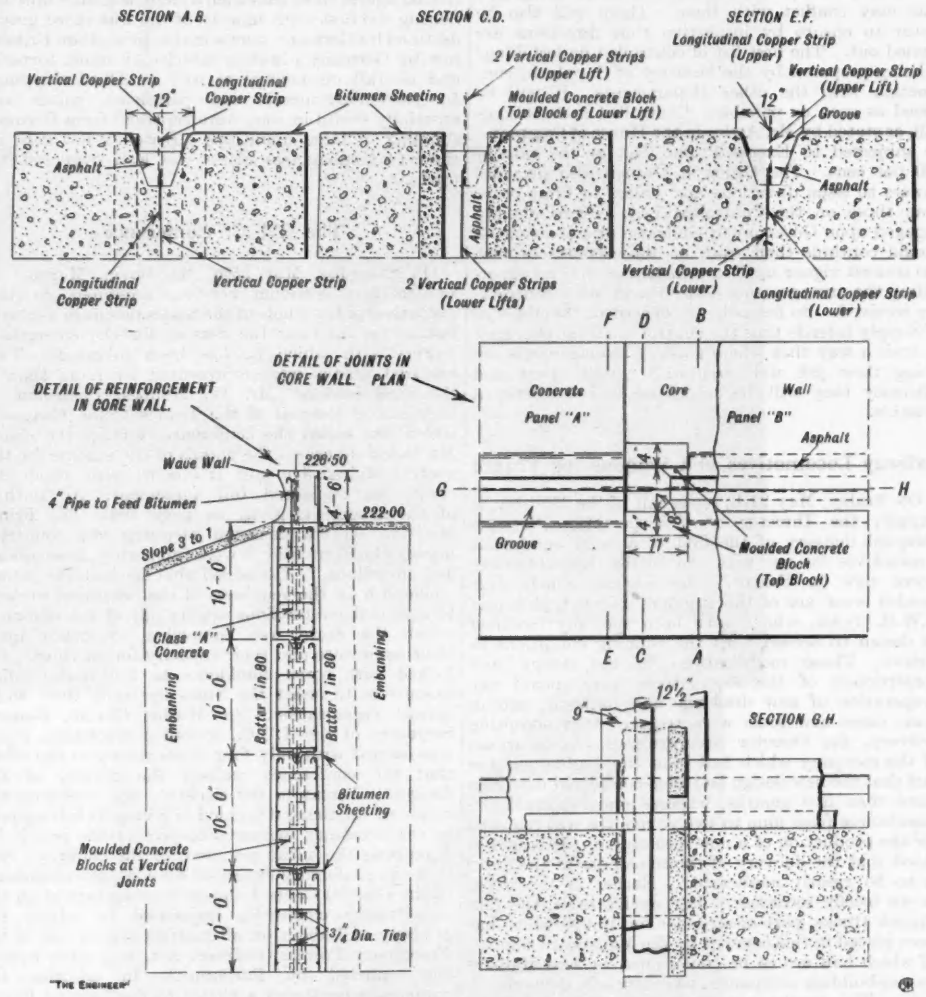


FIG. 2—DETAILS OF CONCRETE CORE WALL

At the site of the Pegu Yomas dam, however, clay suitable for puddle was not available. The consulting engineers therefore designed a very interesting flexible reinforced concrete core wall. This wall, 350ft. long at the top and 130ft. in height, is divided into numerous concrete panels 25ft. wide by 10ft. high, and between 4ft. and 8ft. in thickness according to their positions. This construction is shown in the accompanying drawings. As shown in Fig. 2, each panel is separated from its neighbours by bituminous sheeting and jointed to them, and, in the case of the lowermost panels, to the foundation concrete, by copper strips immersed in bitumen material. Along the top edge of each panel—section E F—there is formed a truncated "Vee" slot about 9in. deep. The lower edge of each panel has a corresponding projection some 3in. deep, able to fit into the slot. Sheet copper imbedded in the concrete projects from each panel into the slot and the two sheets engage against one another. Sealing of the joint is effected by filling the slot with asphalt. It will be easily observed that a quite considerable angular displacement between the upper and lower panels can therefore occur without causing the joint to leak. The vertical joints—see plan view—required a slightly different design. In a rectangular slot in one side of each panel there were cast in when the concrete was poured pre-cast concrete blocks arranged to form a vertical channel. Just as in the case of the horizontal joints copper sheets imbedded in the concrete project from each

panel into this channel, which is filled with asphalt. It will be observed that the vertical channels extend from top to bottom of the dam. Special steps have been taken to prevent escape of the plastic material and feeding pipes are provided so that plastic material can be added if necessary to make up for losses. Inspection manholes are provided on the downstream side of each vertical joint and are furnished with drains so that if any water should pass through the joint it will not enter the downstream banking material. These manholes, which are semicircular in plan, also act as a vertical drain for the banking material immediately behind the core wall, pipes provided with screens passing through their walls at frequent intervals. At the intersections of vertical and horizontal joints the general principles of the design of the straight-forward joints are still followed. The various copper sheets are, however, interleaved as shown by Section G H, Fig. 2. It has been calculated that this core wall is so flexible that the top of the wall could move at least 16ft. out of line at the centre of the dam without permitting the escape of water through the joints.

The core wall is surmounted by a substantial wave wall at the inner edge of the top of the embankment. The top of the wall is 11ft. 6in. above overflow level. Inspection covers are arranged over the tops of the vertical manholes behind each vertical joint. The material overlying the sandy shales on which the dam is founded was used for the banking. It consists of a sandy loam almost free from colloidal clay and stands at a high angle of rest. Shear tests were carried out to ascertain its behaviour under different conditions of loading and saturation before a final decision was made regarding the slopes to be adopted for the embanking. The bank is 20ft. wide at the top and the downstream slope varies from 2 to 1 to 3 to 1. It is broken by three berms 15ft. in width as shown in Fig. 4. The slope terminates at a toe formed of Laterite, which is in turn supported by a retaining wall pierced by drainage pipes from a Laterite mattress varying in thickness between 18in. and 2ft. which underlies the bank. Drainage pillars of Laterite spaced 50ft. apart are provided at each berm. On the upstream side the slope of the banking varies from 3 to 1 to 4 to 1, and is protected from erosion by concrete slab pitching. It terminates at a benching formed of Laterite supported by an arched concrete dam 40ft. in height originally constructed to divert the river through a tunnel while work on the main dam was in progress. This dam is clearly seen beneath the valve tower in the half-tone engraving, Fig. 3. Bull-dozers were used for spreading and consolidating the material of the embankment. They proved very successful, and it was found that the compacted material had a smaller void ratio than the material in its natural state. During the monsoon, however, it was not possible to use these machines and work on the embankment was thus confined to seven months of the year.

Overflow Weir

The estimated maximum rate of inflow to the reservoir amounts to 20,000 cusecs. But owing to the balancing effect of the reservoir, which has a top water area of over two square miles, the calculated maximum outflow is only 8000 cusecs.

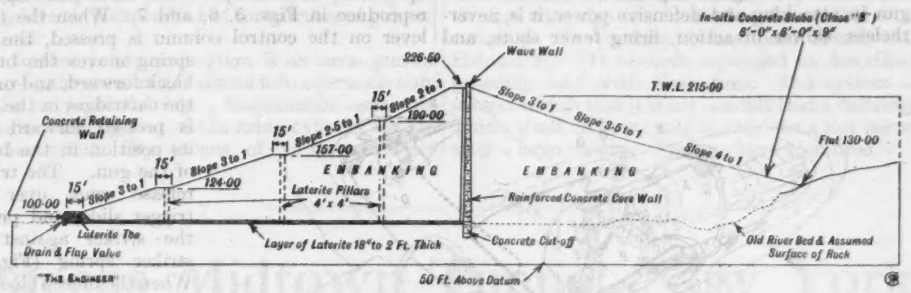


FIG. 4—CROSS SECTION OF DAM

The situation of the overflow weir has already been mentioned. It has a length of 215ft. After passing the weir, flood water is carried to the valley below in a concrete channel curved in plan, gradually diminishing in width from 215ft. to 60ft. in accordance with the increasing velocity of flow, and "super-elevated" to prevent the water piling up on the outer side of the curve. Some photographic views of the dam, overflow channel and valve tower are reproduced on page 496.

(*To be continued*)

FIG 3—MAIN DAM AND VALVE TOWER

The Armament of the Heinkel He. 112 Fighter Monoplane

IN an article which appears in the *V. D. I. Zeitschrift*, of October 14th, Ing. P. Madlener, of Berlin, discusses the problems connected with the arming of single-seat fighter aircraft, and describes the solution which has been found satisfactory for the Heinkel He. 112 fighter monoplane. In introducing the subject the author states that the duty of the modern fighter aircraft is to ward off enemy attacks and to make direct attacks on enemy bombers, while in the case of reconnaissance and transport machines, as well as machines called upon to accompany other aircraft, these duties may be extended to attacking ground targets, such as troops, armoured vehicles, battery positions, &c. In order to carry out these duties, high flying speed is needed, with good manœuvrability, and quick climbing characteristics. In spite of the high flying speeds, associated with recent air fighting, and the question of contacting, which does not call for consideration here, the armament of a fighter must include considerable gun power, which is achieved on the one hand by the high velocity of fire, and on the other hand by the incorporation in the structure of the aircraft of several machine or automatic guns which can be fired at the same time.

The principal technical features of the Heinkel He. 112 machine are as follows:—The aircraft is a low-wing cantilever monoplane, the wing roots being swept up where they join the fuselage, as indicated in the sketch reproduced in Fig. 1. The outer portions of the wings, which are elliptical in cross section, taper in thickness. The whole trailing edge of the wings is utilised, and is hinged, the outer portions acting as ailerons, while the inner portions serve as landing flaps. All-metal construction is employed, the fuselage being of light metal monocoque design, with a tail unit of the cantilever monoplane type, all in light metal, having statically balanced elevators with trimming tabs. A retractable undercarriage is fitted. As shown in Fig. 2, the cockpit is enclosed and is arranged over the trailing edge of the wing. The engine shown is a water-cooled 1070 H.P. Mercedes-Benz twelve-cylinder inverted-vee unit, driving a constant-speed two-bladed airscrew. The fuel tanks are placed in the centre portion of the wing, and the radiator is below the engine. Alternatively one 670 H.P. Junkers Jumo 210. G. engine may be fitted to this machine. The dimensions of the machine are span 9·1 m., length 9 m., height 3·7 m., and wing area 17 square m. With the Mercedes-Benz engine the weights are 1900 kg. empty, and 2600 kg. loaded, the weights with the Junkers engine being slightly less.

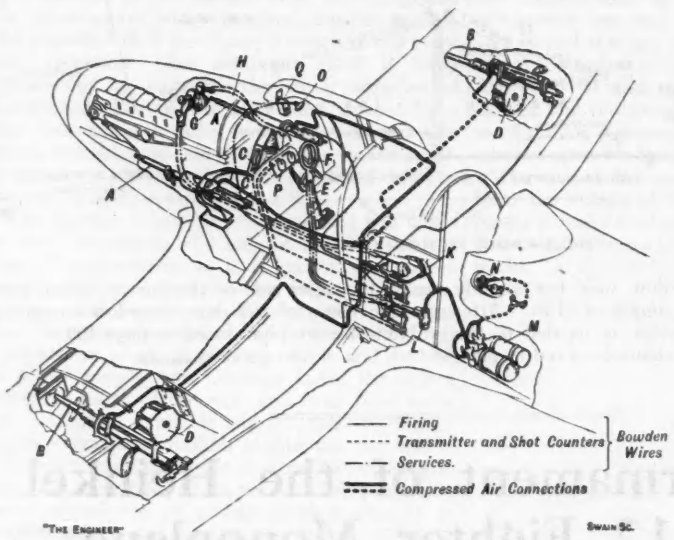
The armament with which this article is principally concerned comprises two fixed machine-guns in the sides of the fuselage, firing through the airscrew, and two automatic guns placed on the wings outside the disc swept by the airscrew. Racks for six 10 kg. bombs in the outer wings are also of interest.

In the fighter aeroplane of this particular type, the pilot is also the gunner, and the armament is therefore fixed in the direction of flight, so that trajectories of the guns (Fig. 3), cross at a given distance from the front of the machine, called the "fighting range." By means of an aiming device the armament is brought on the target by aiming the whole aircraft. When aiming with a ring sight, it is necessary for the pilot to bring into line the ring, bead, and the object aimed at, by bringing the eye on one point and keeping it fixed. On this machine, this procedure is made unnecessary by the use of a reflector sight, shown in Fig. 4. By the simple optical arrangement shown, consisting of a plane-parallel glass plate, placed at an angle of 45 deg., the illuminated image of the cross-wires is reflected in the direct line of vision, with a focus at infinity, and the gunner sees the reflected image, and at the same time his target through the glass. He is thus able to keep both eyes open, and can move slightly without spoiling accurate aim.

The principal armament consists of machine-guns, which in this machine are of the 7·9 mm. Rheinmetal-Borsig pattern. Having good manœuvrability, it is possible for a Heinkel to force an enemy to fight at close range, when the quickly following bullets of the machine-gun are most effective. In other cases, such as the attack of bombers flying in formation, the 20 mm. calibre automatic guns are perhaps a more effective weapon, as the fight can be carried on at a longer range, when the fighter is a smaller target for the defensive fire from the bomber which is being attacked.

While bullets of high penetrating power are fired by the machine-guns, the automatic guns fire explosive shells with highly sensitive charges designed to explode on impact. Both types of

weapons are designed to fire tracer bullets, enabling the path of a projectile to be easily picked out even in daylight. While the automatic gun has some advantages compared with the machine-gun in attacking and defensive power, it is, nevertheless, slower in action, firing fewer shots, and moreover it is heavier and requires more room to install.

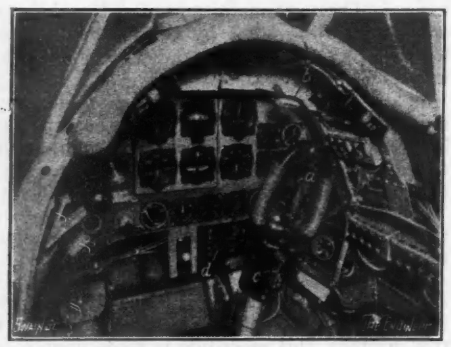


A—Controlled machine guns at side of fuselage.
B—Automatic guns on wings.
C—Ammunition box for machine-guns.
D—Ammunition drums for automatic guns.
E—Control column.
F—Firing lever.
G—Transmitter.
H—Push wire.
I—Remote control panel for all guns.
K—Reloading valve.
L—Firing valve.
M—Compressed air bottles.
N—Filling connections and gauge.
O—Reloading lever.
P—Shot counter.
Q—Reflector sight.

FIG. 1—ARRANGEMENT OF CONTROLS FOR ALL GUNS

Up to the present it has not been possible to design a German automatic gun capable of firing through the disc swept out by the airscrew, and the guns are therefore usually arranged to fire outside the airscrew disc. There are, however, so-called "motor cannon" which fire through the hollow shaft of the airscrew, and in such installations the engine is adapted as a gun support.

The installation of guns in small aircraft presents the designer with certain difficulties. The stresses set up when the gun is fired must be absorbed in the structural members of the aircraft, and above all there must be a steady gun platform if accuracy of aim is to be maintained. The guns and the munition-boxes must be easily accessible, and reserve ammunition must be arranged within easy distance, while wherever possible the guns should form a part of the main structure, as built-on attachments may easily cause considerable loss in flying speed due to increased air resistance.



(a) Firing lever on control column.
(b) Reloading handle for all guns.
(c) Pre-Selector:—Downwards (as shown above), safe position; left, automatic guns; right, machine-guns—Upwards, automatic and machine guns together.
(d) Shot counter.

FIG. 2—VIEW OF CONTROLS IN COCKPIT

For firing machine-guns through the disc swept out by the airscrew a special type of control is fitted, which permits the shot to be fired following the passing of the blade of the air-screw past the line of vision. This control is worked by a cam on the engine. It is very necessary to convey the impulse given from the engine to the mechanism of the gun in the very shortest time. There are different ways of doing this, and the method here described is that used for the 7·9 mm. bore Rheinmetal-Borsig machine-gun.

Assuming that the ammunition strip is in position in the gun and the firing spring compressed, the main parts of the gun and the sequence of operations are shown in the three drawings we reproduce in Figs. 5, 6, and 7. When the firing lever on the control column is pressed, the gun spring moves the breech block forward, and one of the cartridges in the strip is pressed forward into its position in the barrel of the gun. The trigger release runs over the trigger slide, and presses the striker against the striker spring (Fig. 5). When the breech block has reached the barrel at the end of its stroke the locking of the block and barrel begins. The trigger release presses the slide and its pivoted rocker arm down, thereby separating from each other the transmitter plunger and the slide, as shown in the drawing given in Fig. 6. When the gun is ready for firing and is fully locked (Fig. 7), the trigger mechanism releases the rocker arm again, and the plunger of the transmitter is brought by the rising of the rocker arm into contact with the rocker arm, pushing it into contact with the push-wire. With the next stroke of the transmitter, the trigger release comes free of the slide and the striker moves forward, igniting the cap and firing the bullet.

The total time between two consecutive shots when controlled is made up as follows:—Let t_1 represent the functioning time required for the operation of the gun, and t the time of waiting between the locking of the gun mechanism ready for firing and the beginning of the next cam stroke of the engine. The following equation then holds:—

$$t = \frac{i}{nz} - (t_1 + t_2)$$

where t equals the waiting time, t_1 the functioning time, and t_2 the control time, n equalling the number of revolutions of the airscrew, z the number of blades of the airscrew, and i the number which gives the smallest positive value of t. The control time t_2 is taken to represent the time from the beginning of the impulse received from the cam on the engine to the release of the striker and the firing of the bullet. The times t_1 and t_2 can be taken as approximately constant. From the value of the sum of the three times, t/t_1 and t_2, the number of shots per minute from the machine-gun in relation to the speed of the airscrew is obtained. The characteristic relation which is thus established is shown in the accompanying drawing, Fig. 9, while Fig. 8 indicates the position of the shots fired. It will be noted that the non-controlled firing rate of 1200 bullets per minute is under controlled firing reduced to 960 bullets per minute because of the values of the times t_2 and t.

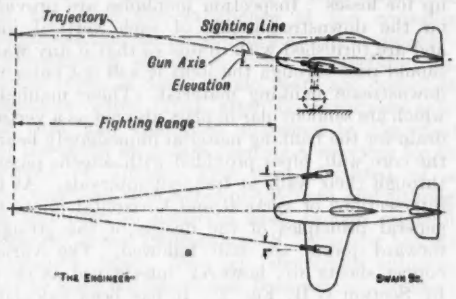


FIG. 3—ARRANGEMENT OF AUTOMATIC GUNS ON WINGS

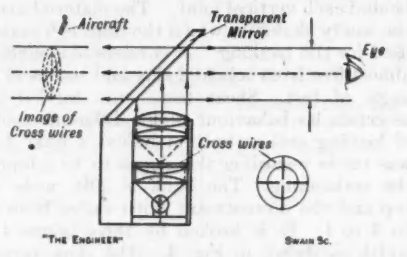
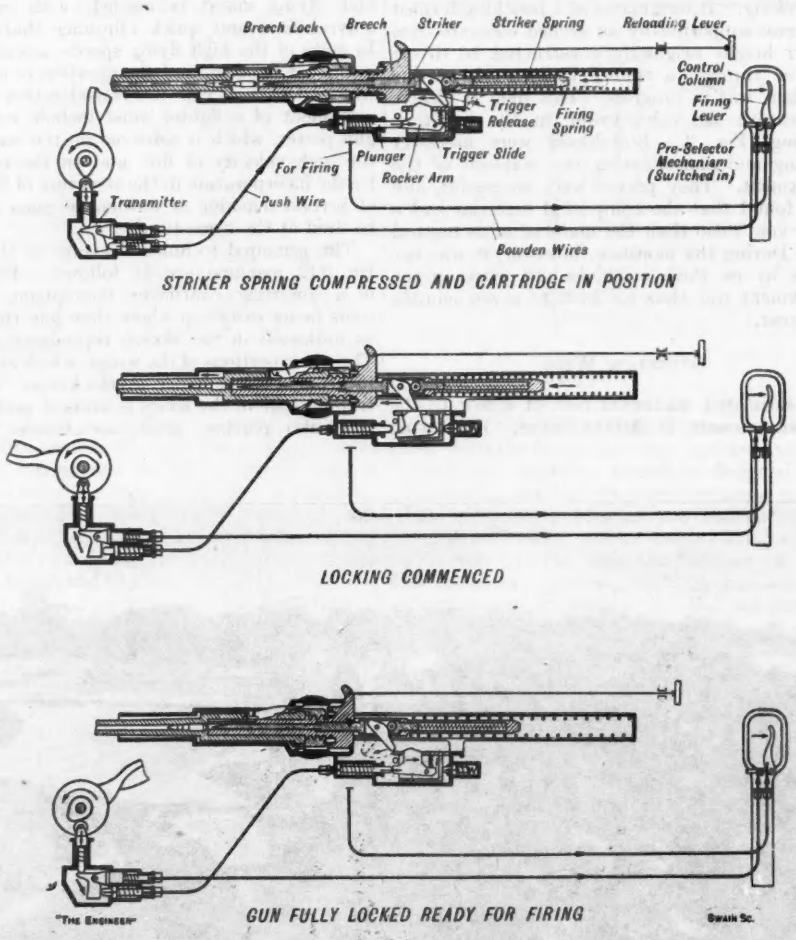


FIG. 4—DIAGRAM OF REFLECTOR SIGHT



FIGS. 5, 6, AND 7—MACHINE GUN OPERATING CONTROLS

The principal features of the fire-control arrangement are illustrated in Fig. 1. The firing lever, in the type of aircraft we are considering, is

incorporated in the top of the control column. It must be operated without great physical effort if the aircraft is not to be deflected from accurate aim. In the case of the installation of more than one pattern of gun, or groups of guns of differing calibre, it is advisable on tactical grounds to provide for the firing of groups of guns or the complete armament together as may be needed. As it is impossible to do so by any hand-operated device, for the effort necessary would be too large, a fire-control system has been devised which can operate the guns by means of a light finger pressure, and which also applies to the reloading of a gun which has jammed. Such a system was designed by the Rheinmetal-Borsig Company in collaboration with the Ernst Heinkel Aeroplane Works, and was first installed in the Heinkel He. 112 herewith described. With a small alteration this same

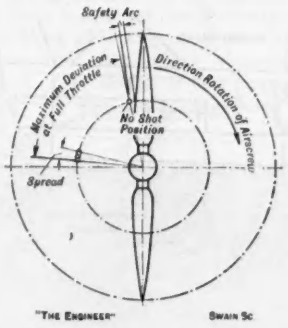


FIG. 8—SHOTS IN AIRSCREW DISC WITH CONTROLLED FIRING

system can be applied to other types of aircraft fitted with fixed armament.

In the Heinkel He. 112, the fire-control panel is placed within the fuselage behind the gunner, and the operating medium is compressed air, which is available on most aerodromes. The compressed air is stored in two light steel bottles, each of a capacity of two litres, which are charged to a pressure of 150 atmospheres or about 2132 lb. per square inch. The actual operating pressure is reduced to 30 atmospheres by means of reducing valves attached to the air bottles, and this pressure serves to control the firing of the guns, to reload with ammunition, or to restart a gun which may have jammed. The reloading cylinder forms part of the gun, and a short pull on the reloading handle opens the air supply to the reloading valve by means of a Bowden wire control, setting the gun in the position for firing. When the reloading handle is released, the valve closes and the pipe line is automatically exhausted, the

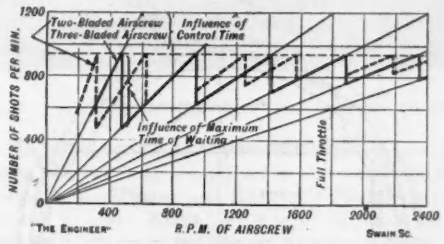


FIG. 9—RELATION OF FIRING AND AIRSCREW SPEEDS

valve spindle of the air valve being returned to its seat by means of a spring. In the case of only one gun refusing to fire, all the guns are instantly reloaded, as in the heat of an aerial fight it would be difficult for a gunner to pick out the damaged or defective gun. In the worst case, three guns may be without ammunition, and the reloading is without effect, but the fourth gun may be successfully reloaded. For accuracy of aim, it is very necessary that there should be immediate firing when the firing lever is operated, and for this reason both the firing lever and the cylinder operating it are placed near together, as indicated in the drawing, Fig. 1. So that the gunner can operate either the machine-guns at the side of the fuselage, or the automatic guns arranged on the wings, a preselection device is attached to the control column just below the firing lever (Figs. 1 and 2). If the preselection device is set for the desired group of guns, then on pressing the firing lever the firing valve is immediately brought into operation, and the compressed air gives an instant sharp opening of the firing cylinder operating the guns required. If the preselection is upward, both preselecting valves are opened and both groups of guns are fired together. The downward position shown in Fig 2 is the safe position, when both valves are closed and the firing lever itself is locked in the safety or "no shot" position. As all the guns can be fired with the use of one firing valve, the power to be expended in pulling the firing lever is independent of the number of guns to be fired.

A further safety precaution is an arrangement whereby the transmitter comes into operation only at the moment of firing, a transmission actuating cylinder forming part of the firing cylinder for the machine-guns. By means of an intermediate throttle, the compressed air which reaches the actuating cylinder is delayed in its exhaust, so that the transmitter remains in position for some time after the firing has ended. By this means the last cartridge can be fired under control with certainty. In practice it has been found that Heinkel He. 112 aircraft, equipped as described, generally land with clear guns. The system of control is such that it is not possible that a cartridge ignites itself on being introduced into a hot barrel after a large number of bullets have been fired.

Queens Midtown Tunnel, New York

No. I

THE Queens Midtown tunnel—the first vehicular tunnel to underrun the East river—was holed through on November 8th, 1939. It is the expectation of the New York City Tunnel Authority, under which the project is going forward, that the tunnel will be completed before the end of the current year.

The Queens Midtown tunnel will cost, when finished, an estimated total of 58,365,000 dollars; and that sum will cover construction outlays, the purchase of land and property, engineering work, administrative charges, together with interest during construction, miscellaneous expenses, and contingencies. The cost, although a large sum, will be justified if, as fully expected, this subaqueous vehicular route serves to lessen in a commensurate degree the traffic congestion that occurs so often on the bridges which have heretofore offered the only permanent routes across the East river. The primary cause of all the trouble is the ever-increasing volume of motor traffic which makes use of the East river bridges.

The new tunnel is not just one more means of linking the Borough of Manhattan, on the west side of the East river, with the Borough of Queens, on the opposite flank of that fast-moving stream which is much used by vessels of all sorts and sizes. Furthermore, the Queens Midtown tunnel is not intended to serve motor vehicles originating only within the two boroughs thus connected. The tunnel will really function as another traffic artery that will benefit a far more comprehensive territory—the so-called Metropolitan Zone. That zone embraces not only the five boroughs of the City of New York but populous areas of northern New Jersey, western Connecticut, and the south-eastern part of the State of New York—a combined expanse within which 12,000,000 people live. The Borough of Manhattan in varying degrees is the financial, commercial, industrial, shopping, and entertainment centre of the zone. Accordingly, the heaviest tide of vehicular traffic is daily directed in and out of Manhattan, not to mention the movements of automobiles, motor lorries, and buses which have their normal routes limited to local service.

Many broad thoroughfares are so congested with vehicles capable of high speed, and yet obliged to travel slowly, that competent experts have stated that the time so lost in transit cost the business houses of the city as much as half a million dollars daily. Some of the circumstances leading up to authorisation of the Queens Midtown tunnel have thus been explained by Mr. Ole Singstad, chief engineer of the New York City Tunnel Authority:—"The Queens Midtown tunnel is being constructed to aid in the relief of traffic congestion and overcrowding which have become common on the East river bridges that connect downtown and midtown Manhattan with Long Island. Conditions requiring relief are particularly evident on the Queensborough bridge and its approaches which, even since the completion of the Triborough bridge in 1936, is the only crossing of the East river in the stretch of more than 5 miles, north and south from the Williamsburg to the Triborough bridge. With the provision of more traffic lanes on the four East river bridges before the Triborough bridge was available, and improvements in their approaches, those four bridges, the the latest of which was constructed more than 30 years ago, carried, in 1936, 90,000,000 motor vehicles. After the Triborough bridge was in service, 100,000,000 vehicle trips were made annually over all five of the East river bridges.

"Increases in roadway capacities have not solved the problem of impeded and inconvenient peak-hour travel which is caused to a large extent by approach conditions. In spite of the relief afforded by the Triborough bridge, the volume of traffic carried by the Queensborough bridge—which had reached the figure of 36,000,000 vehicles in 1933, is still far above that which should rationally and normally be carried by one facility and concentrated in inadequate approach areas to interfere and conflict with other traffic of the vicinity. It is estimated that the Queens Midtown tunnel, one mile to the south of the Queensborough bridge, will divert from that crossing at least 3,500,000 cars as well as materially lighten the traffic burdens of the other bridges farther downtown. Traffic surveys and studies show that of the total of 10,500,000 vehicles which it is estimated will travel through the Queens Midtown tunnel in the first year of its operation, quite 6,275,000 will be diverted from existing crossings and 4,225,000 will be 'induced' traffic arising purely from the relief of congestion and the added convenience which the tunnel will afford. It is expected that the Queens Midtown tunnel will reach its maximum annual capacity of 16,000,000 vehicles during the twelfth year of operation." According to the latest survey, it is estimated that vehicular crossings of the East river during the present year will probably total 115,000,000.

The New York City Tunnel Authority was created by act of the New York State Legislature in January, 1936, as a public benefit corporation, in effect continuing, with a broader scope as to projects, the Queens Midtown Tunnel Authority which had been created in May, 1935; and its undertakings are to be operated and their costs amortised out of revenues from tolls, without any expense to taxpayers. When all the liabilities of the Authority shall have been met, then its corporate existence will terminate, and all its rights and properties will pass to the City of New York. The Queen's Midtown tunnel project has been financed by the Public Works Administration with a loan of 46,130, 000 dollars, and a grant of 11,235,000 dollars. The first ground for the project was broken on October 2nd, 1936, at the site of one of the two construction shafts. Work on the contract for driving the two tubes of the tunnel was not started, however, until July 9th, 1937.

The course traced by the Queens Midtown tunnel beneath the river, as shown in an accompanying drawing, starts near 42nd Street at the Manhattan bulkhead line and runs from north-west to south-east to the Queens shore at the water-front end of Borden Avenue, but the entrance and exit plazas are considerably farther inshore in Manhattan and in Queens. On the Queens' side of the river, in Long Island City, the positioning of the combined entrance and exit plaza presented no difficulties either in the continuation of the tunnel line or in reaching the ground level in the midst of a built-up section of the community. On the Manhattan side of the river, however, the ultimate situations of the separate exit and entrance plazas presented engineering difficulties which entailed the preparation of a large number of plans before a satisfactory solution was obtained.

The ground surface, which is comparatively flat and low in elevation south of 40th Street, between Third Avenue and the East river, rises rapidly to the west of this area, the gradients of the crosstown streets, in some cases, exceeding the maximum permissible tunnel gradients. On this account, if the tunnel had been carried west of Third Avenue its length would necessarily have been increased to an uneconomical and impractical extent. In addition, the values of property and improvements increase to such large amounts as the centre of the midtown section is approached as to become prohibitive in so far as the allowable costs of the tunnel project are concerned, while the volume of local traffic on the crosstown streets,

which is not heavy east of Third Avenue, reaches proportions to the west that would seriously affect the freedom and convenience of travel to and from the tunnel plazas and approaches if they were situated there.

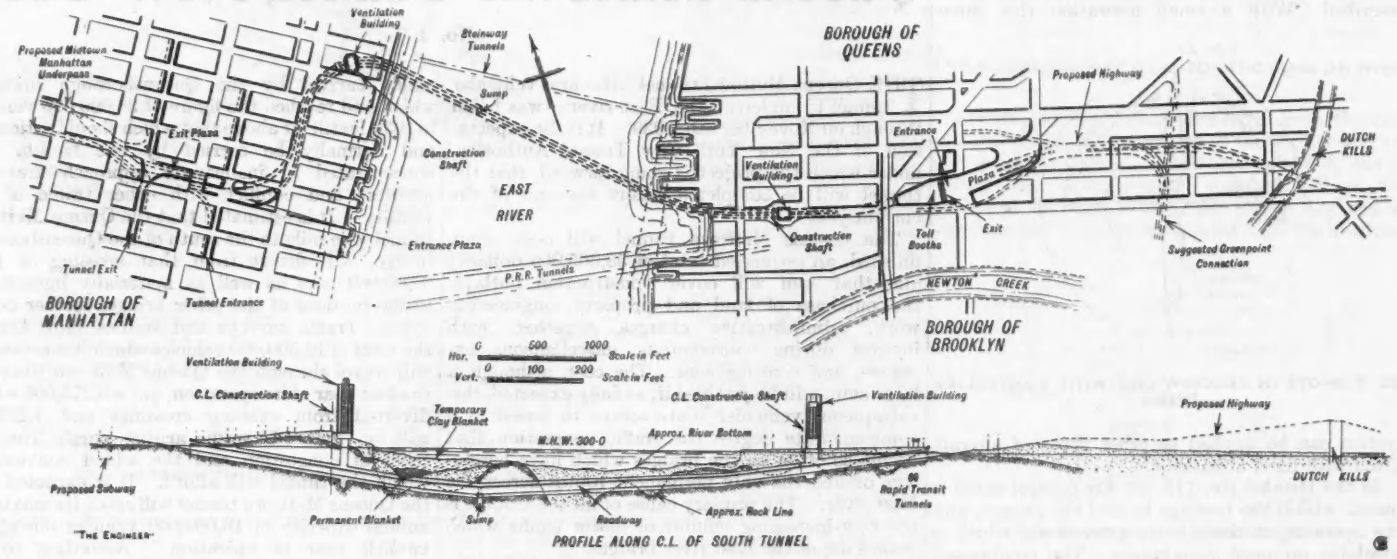
These conditions, imposed by topography, property costs, and street traffic, confined the positions of the tunnel entrance and exit plazas and approaches to the more favourable low-lying territory nearer the East river, but the problem was complicated by the fact that, if the alignment followed a straight east-and-west course, the distance between the U.S. pierhead line, where the tunnel structure must be a minimum depth below low-water level, as prescribed by the War Department, and the westerly limit of the area is insufficient to permit reaching the surface, except by the use of excessive gradients. When the project was financed in 1936, a route had been tentatively adopted which called for spiral loops to create the necessary length of line to get to the surface with suitable gradients. This use of spiral loops was a modification and simplification of a considerably more complicated scheme developed by another city agency which had made preliminary plans and studies for the project some years prior to the Tunnel Authority's authorisation to construct it. It was recognised that the tentative plan had undesirable features, requiring extensive study which it had been impossible to make up to the time of the financing of the project, due to the limitations on time and funds. The primary objection to the loops was that they would have proved confusing to a large percentage of drivers because of the reversal of direction of travel, both in entering and leaving the tunnel, and especially at the exit portal. Therefore, the Engineering Department of the New York City Tunnel Authority continued its studies and eliminated the loops by placing the Manhattan exit and entrance plazas between 36th and 37th Streets, north and south, and First and Third Avenues, east and west, and then connecting the cross-river section of the tunnel with those plazas by a long and flat S-shaped link. This arrangement yields very satisfactory approach gradients and has resulted in placing the Manhattan portals where the plazas and the surface approaches of the tunnel can be provided within the fixed limits of the estimated cost of the entire undertaking. Also, this arrangement has permitted separating the entrance and exit plazas as widely as practicable, avoiding concentration of entrance and exit traffic on too small an area; provisions for wider separation north and south would have resulted in steeper gradients and greater property costs to the north, while opposition to the acquisition of park property for tunnel purposes was a restricting influence in moving southward. Under the final plan, traffic entering or leaving the tunnel is distributed by way of the several crosstown streets which intersect the surface approaches, these streets having ample capacity to handle tunnel traffic in addition to street traffic.

Each of the twin tubes will provide a 21ft. roadway for two lanes of traffic; and one tube will be devoted to west-bound traffic and the other tube will carry east-bound traffic, when the tubes are available for service. The roadways are widened on curves; and the minimum clear headroom is 13ft. 5in. The full length of the crossing is 7865ft. for the west-bound tube, and 7400ft. for the east-bound tube; and the distance between portals is 6414ft. and 6272ft., respectively. The maximum up gradient in the tunnel is 3·5 per cent. and the maximum down gradient is 4 per cent. The minimum radius of curvature is 500ft., except for short curves at the Manhattan portals where the radius is 450ft. The plazas are widened from the two tunnel lanes to six lanes for both exits and entrances. The three-lane surface approaches in Manhattan for exit are between Second and Third Avenues, extending from East 34th to East 41st Streets; and for entrance, the approaches are between First and Second Avenues, and extend from East 34th to East 40th Streets. Between portals, the various types of construction are according to the following tabulation :—

	Approximate lengths South tunnel ft.	North tunnel ft.
Steel bent and concrete (Manhattan) ...	390 ...	384
Rock tunnel; 32ft. 10in. dia. struc. steel lining (Manhattan)	958 ...	1134
Shaft construction (Manhattan)...	65 ...	65
Shield-driven tunnel, 31ft. dia. cast iron lining	3767 ...	3751
Shaft construction (Queens)	35 ...	35
Steel bent and concrete (Queens)	1057 ...	1045
Total	6272 ...	6414

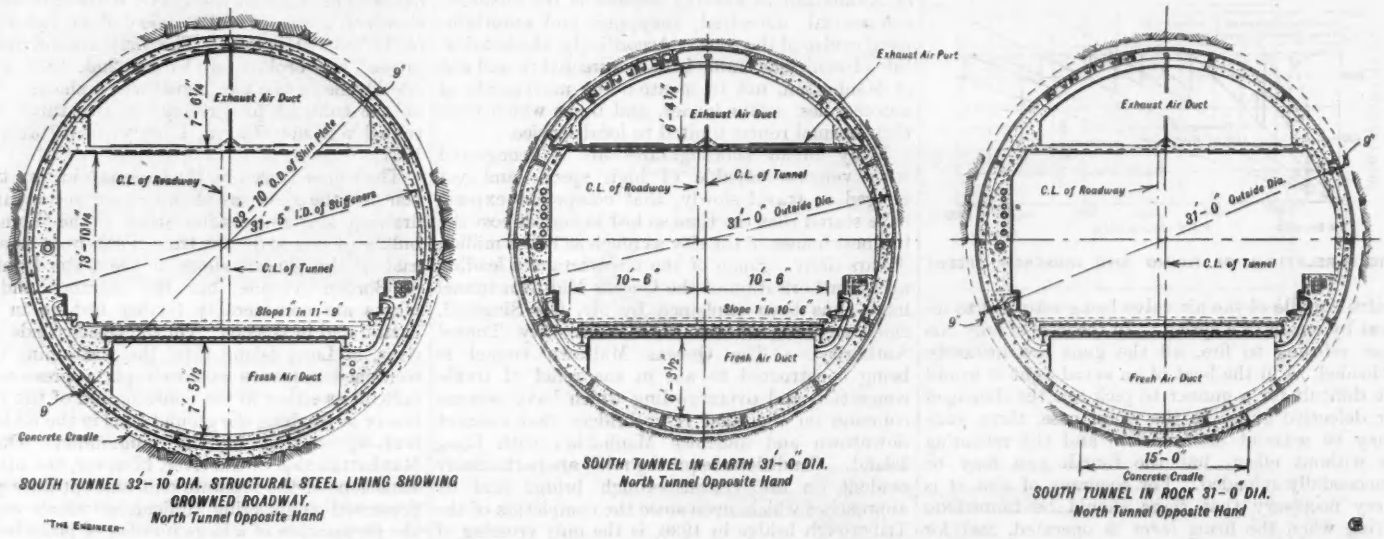
The alignment of the tunnel, as now adopted, best harmonises the topographical, engineering, operating, and economic requirements. The approach gradients are obtained while satisfying the War Department's restriction concerning the minimum depth of tunnel structure between pierhead lines and the maintenance of a minimum cover of 13ft. over the tops of the twin tubes. The length of the under-river section of the tunnel is 3098ft.; the maximum depth of the top of the tunnel below mean high water is 73ft.; with corresponding depth of 95ft. to the roadway and 104ft. to the bottom of the tunnel. The two tubes beneath the river are 60ft. apart, centre to centre, and 29ft. apart between the exteriors of their adjacent linings. A mid-river sump and pump chamber is provided, in rock, near the low point of the river crossing—that is, approximately 1170ft. east of the Manhattan ventilation shaft. The top of the tunnel is 55ft. below mean high water at the Manhattan pierhead line and 52ft. at the Queens pierhead line.

The cross section of the Queens Midtown tunnel tubes corresponds with the similar section of the Lincoln tunnel, but differs in dimension from that of the Holland tunnel. That is to say, the cast-iron lined sections of the Queens Midtown tunnel



PROFILE ALONG C.L. OF SOUTH TUNNEL

PLAN AND PROFILE OF QUEENS MIDTOWN TUNNEL



CROSS SECTIONS OF TUNNEL

are 31ft. in outside diameter instead of 29ft. 6in. as in the case of the Holland tunnel. This increased diameter permits a 21ft. roadway instead of 20ft. as in the original vehicular tunnel under the Hudson river, and also makes possible air ducts of larger sectional areas. Throughout the rock tunnel sections, where the diameter is 32ft. 10in., structural steel linings have been adopted. Cross-sectional drawings of typical sections are reproduced.

Speaking of the two types of tunnel lining, Mr. Singstad thus explains the reasons for the adoption of each in a single undertaking:—"The shield-driven portions of the Queens Midtown tunnel are cast iron lined. This is the standard material for the purpose and has been such since the early days of this kind of tunnel construction. It is well adapted to the severe loads that come on it when the shield jacks are applied, and it can be made watertight. The rock tunnel on the Manhattan side is lined with a lining of welded steel plate similar to that used in the rock-tunnel sections of the Lincoln tunnel. The design of this lining is based fundamentally on the design first used for the Detroit-Windsor tunnel, and later in Boston. Watertightness is accomplished in the steel lining by welding the joints; and this type of lining may be used to good advantage where concentrated shield jack thrusts do not require a cast iron lining, except where there is a head of water producing a flow or seepage through the joints to be welded, making proper welding for watertightness difficult or impossible. Alternate designs for light cast iron or welded steel lining for rock tunnel in free air were included in the contract for the Manhattan section of the Queens Midtown tunnel, and, as in the cases of similar contracts for the rock tunnel approaches of the Lincoln tunnel, steel showed a substantial saving as compared with cast iron. I believe that where there is a choice between cast iron and steel lining, and conditions for welding are satisfactory, that, besides reasons of economy in cost, the steel is preferable. Possibility of corrosion on the outside of the lining, which is sometimes referred to as a disadvantage of steel lining, is prevented by filling the space between the rock and the tunnel with grout. When expansion and contraction take place with changes in temperature, there is a flexibility in the steel lining which the cast iron lining does not have. Cast iron lining sometimes is not completely watertight in the winter season. The outside diameter of the steel lining, 1ft. 10in. greater than that of the cast iron lining, has afforded an interior increased width for roadways on curves."

Between portals, the Queens Midtown tunnel will be ventilated by the familiar transverse method as first developed for the Holland tunnel after extensive preliminary investigations. The fresh-air ducts lie below the roadway, with fresh-air flues discharging into the tunnel at frequent intervals just above the level of the roadway; and vitiated air will be withdrawn through ports in the tunnel ceiling, connecting with the large duct above the ceiling, and moved thence to one or the other ventilating buildings, where it will be discharged through an évasé stack at the top of the given ventilation building.

The tunnel has two ventilation buildings in which the fans and other essential equipment are housed—one in Manhattan and the other in Queens. The Manhattan ventilation building is a six-storey structure with two évasé stacks rising about 14ft. above the roof level. This building is octagonal in plan and is supported partly on the ventilating shaft and partly on piers carried down to rock. The structure has a ground area of about 13,600 square feet, is about 122ft. high, and has an interior space of 1,500,000 cubic feet. Its framing is of steel, its walls are of brick, and its floors of concrete. The Queens ventilation building is a five-storey structure with two évasé stacks which rise about 30ft. above the roof level. The building occupies a ground area of 107ft. by 113ft., has a height of 119ft., and the volume of available space is 1,236,000 cubic feet. The building is partly supported on the steel bent structure of the tunnel underlying it and partly on steel shell piers which are carried down to bed-rock. The superstructure of this ventilation building is, in general, similar to that of the Manhattan ventilation building.

VENTILATION SHAFT IN COURSE OF CONSTRUCTION

The tunnel is to be ventilated from portal to portal, and each of the two tubes is subdivided into four ventilation sections, consisting of the two entrance sections from the portals to the two ventilation buildings and the two river sections from the two buildings to a central point under the river. Each of these sections is served by three blower fans, supplying fresh air, and three exhaust fans to remove vitiated air, excepting the entrance section at the Queens end of the tunnel, where only two fans of each kind are necessary. The fresh air is drawn into each of the ventilation buildings through intake louvres in the walls of the building, and the vitiated air is vented from the stacks at the top. The normal maximum ventilation service will supply 2,826,000 cubic feet of fresh air per minute, which will be equivalent to changing the air in the entire tunnel 42 times in the course of an hour. This is counted upon to keep the CO_2 content within a permissible maximum of 2·5 parts per 10,000 parts of air.

A total of 46 fans will be installed in the two ventilation buildings, and the fans are of the double-inlet, backward-curved blade, centrifugal type, and are fully housed. The motors are totally enclosed, fan-cooled, and of the squirrel-cage induction type. The fan speeds are relatively low while the motor speeds are relatively high, characteristics which have led to the adoption of silent-chain transmission drive. Exhaustive study has indicated that three speed steps on each fan would give the maximum operating economy. Each fan will be driven by two motors—a single-speed motor to drive the fan at full speed, and a second smaller motor which will drive at two-thirds full speed and at one-third full speed. Two of the fans, where three are allotted for a given duct section, are capable of providing normal maximum ventilation when running at full speed. In practice, the intention is to operate all three fans at reduced speed. The arrangement is such that power consumption for ventilation will show considerable economy compared with that of the arrangement for the Holland tunnel.

(To be continued)

The Newcomen Society

THE summer meeting this year of the Newcomen Society, which has been announced to take place in June, will, on account of existing circumstances, be on a restricted scale, as shown by the following programme.

Members who can attend the meeting are asked to notify the Assistant Secretary of their intention to do so, not later than June 7th. Members may bring guests.

Thursday, June 13th.—9.45 p.m., assemble at the Institution of Mechanical Engineers, Storey's Gate, S.W.1.; 10 a.m., depart by motor coach for Carshalton. Tidemill site at Battersea may be pointed out *en route*. Visit Messrs. John Smith and Co., Grove Works, Devonshire Road. Overshot waterwheel; grass-hopper engine, &c. Surrey Iron Railway track to be seen *en route*.; 11.30 a.m., visit the Hackbridge Chamois Leather Company, Ltd., Beddington Corner. Poncelet waterwheels; fulling stacks; 12.45 p.m., lunch at the "White Hart," Mitcham Green; 2 p.m., depart for Greenwich; 3 p.m., arrive National Maritime Museum. Reception in Library by the Director, Sir Geoffrey Callender, M.A., F.S.A. Model by Wren of the Cupola of the Hospital, recently discovered; models of block-making machinery, 1801; 5 p.m., tea in the Museum Restaurant; 5.30 p.m., depart for Storey's Gate.

Friday, June 14th.—9.45 a.m. for 10 a.m., assemble at Messrs. Francis Higgins and Son, Ltd., 9, Newman Street, S.W.1. Silversmith's work.; 11 a.m., leave for Messrs. W. and C. Nightingale, 70, Old Street, E.C.1. Beam Engine, &c.; 12.45 p.m., meet for lunch at Manchester Hotel, opposite Aldersgate Street Station; 2 p.m., leave by coach for New Barnet; 2.45 p.m., visit Abbey Folk Park, reception and talk on some exhibits by the Director, Father J. S. M. Ward, M.A.; 4.45 p.m., tea in the grounds; 5.30 p.m., depart by coach to town, discharging Storey's Gate.

The *Quarterly Bulletin* of the Society records that at the March meeting, held at the Institution of Civil Engineers, two papers were read in abstract by the Honorary Secretary. The first, by Mr. W. T. O'Dea, was entitled "Electrical Invention and Re-Invention: A Study of the Past as a Stepping Stone to the Future." It was in complete accord with the sentiment embodied in the motto on the Society's badge. "The history of engineering," the author remarked, "has a deeper significance than can be supplied by a mere catalogue of events. It has been the privilege of the author to examine the circumstances surrounding many notable inventions and their inventors. This examination tends to show that invention may be broadly classified according to (*a*) the way in which the inventive processes were tackled; (*b*) the circumstances stimulating these processes; (*c*) the circumstances created by these processes; or (*d*) later circumstances fructifying previous invention." These classifications were developed with considerable skill, and one particularly valuable section discussed hesitations on the brink of discovery and the great value of pertinacity. At every stage in development there were instances of phenomena explored not quite far enough, or other phenomena discovered and not fully appreciated. Sometimes there seemed to be no logical reason for delay in adopting an invention.

The second paper, by Mr. John R. Nichols, dealt with "Amédée Bollée—Pioneer of Mechanical Road Locomotion." The author explained that owing to a personal interest in bell founding, he had been fortunate enough to make contact with Monsieur Pierre Bollée, who had furnished him with much information on the activities of the family in connection with the early days of mechanical road locomotion. The Bollées came of a long line of itinerant bell-founders, but about a hundred years ago the then head of the family, Ernest Sylvain Bollée, decided to relinquish the traditional craft manner of itinerancy and build a permanent foundry; this he did at Le Mans, Département de Sarthe, where, in addition to casting bells, he made hydraulic rams and pumping windmills. His eldest son, Amédée, born in 1844, while devoting the greater part of his time to bell-founding was attracted by the problems and possibilities of mechanical road locomotion and in 1872 he began the construction of a steam vehicle. Mr. Nichols' paper made it clear that with, or without, pertinacity of purpose the path of a pioneer is a hard one to travel.

The final meeting of the session on April 24th was held at the Science Museum, part of which has been re-opened to the public. The first paper, entitled "A Picardy Post Mill," was submitted by Enid and Rex Wailes, but despite a pressing invitation from the chair, Mrs. Wailes could not be induced to read it. It was illustrated with lantern slides, and once more proved the authors are entitled to be considered as experts in all that pertains to mill-wrighting as it was practised in the past.

The second paper, by Dr. Thomas T. Read, of Columbia University, dealt with "The Earliest Industrial Use of Coal," and was read in abstract. The conclusion reached by the author was that the earliest use of coal as a fuel was not made by the culturally advanced people of ancient times, but by native people in regions where local conditions were

conducive to its use. Since such people either had no native literature, or it had not been preserved, it seemed unlikely that it would be possible to establish a date or a place for the earliest industrial use of coal.

Valve Production by the Extrusion Process

THERE has recently been introduced into this country by Daniel Doncaster and Sons, Ltd., of Sheffield, a process for the production of valves for internal combustion engines by extrusion. This process, which is already in considerable use in America, is claimed to have notable advantages compared with hand forging and electric upsetting, the methods at present employed in this country. Hand forging is, of course, a relatively slow method. But it is one which can be applied to somewhat intractable

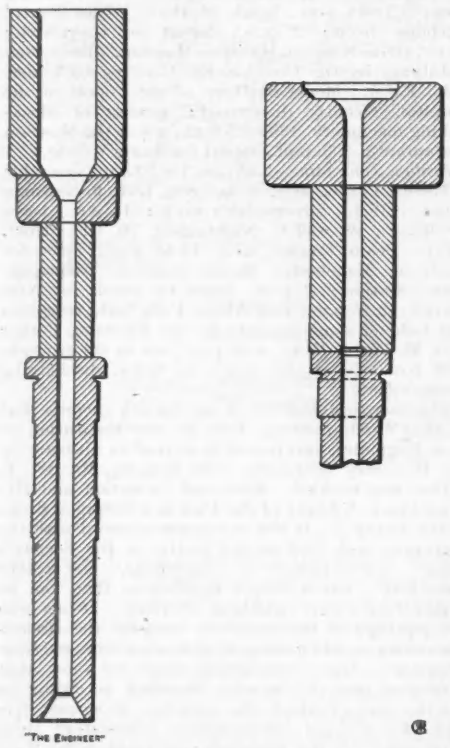


FIG. 1—EXTRUDING AND FINISHING DIES

materials and results in the production of very high quality valves since it permits the "humouring" of difficult steels and provides plenty of work upon the piece to break down the ingot structure and control the grain flow. Electrical upsetting, by contrast, is suitable for quantity production and is so used particularly for inlet valves. It will be remembered that in this process a suitable length of ground rod is gripped at one end by a movable electrode, whilst the other abuts against a plate forming a second electrode of a resistance heater. The passage of current heats the rod and when the correct temperature is reached the movable electrode advances, thus "upsetting" the heated portion and forming a globular head on the end of the rod. By drop-stamping or pressing this head is formed to the correct shape. The limitation on this process is provided by the severe "bursting" effect of the upset upon the fibre of the steel which results in any incipient surface defects being opened up. A bad example is shown on the left in Fig. 5. Consequently the process is unsuitable for use in the production of very high-quality valves such as those used in aircraft engines, nor does it readily lend itself to the working of the more intractable heat-resisting steels used for heavy duty valves. The extrusion process now worked by Daniel Doncaster and Sons, Ltd., is said to be the standard method in America, and high quality products, it is claimed, can be rapidly produced.

Valves made by the extrusion process are now being subjected to exacting tests in aero-engines by leading aircraft engine manufacturers—tests which it is expected they will meet satisfactorily.

For the extrusion process the press is set up with roughing and finishing dies side-by-side. In Fig. 1 is shown a typical drawing of dies for the process—the extruding dies to the left and the finishing dies on the right. Fig. 2 is a photograph of a typical set of extruding dies, comprising, from top to bottom, sleeve die in which the press plunger works, taper die for neck and stem, parallel sleeve, and the ejector sleeve; their relationship is evident also from Fig. 1.

The valve begins as a "slug" sheared (or sawn off in the case of high-grade valves) from the bar; the slug is seen at A, Fig. 3. The proportions of the slug can be varied considerably as regards ratio of length

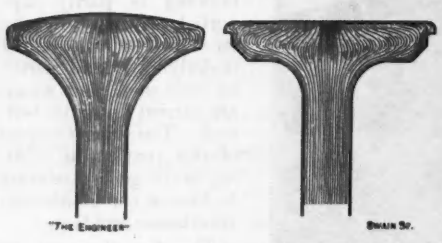


FIG. 4—GRAIN FLOW IN VALVE HEADS

to diameter, to control the work put upon the valve and the direction of grain-flow. These points have an important bearing upon the character and properties of the finished valve. The slug is heated to the correct temperature and inserted in the sleeve die. The plunger of the press then enters the die, and the slug is forced downwards through the taper die and the stem of the valve is formed by extrusion of the plastic hot metal. The extrusion action occupies only a second's time. On the return stroke of the press, the "use" or roughed valve (B, Fig. 3, part sectioned to show the extrusion effect) is lifted by an ejector pin from below, transferred to the finishing dies, and the rough head pressed to finished shape (C, D, E, Fig. 3).

It will be evident that, during the extrusion and subsequent finish pressing, work is put upon both stem and head in adequate amount to ensure the thorough working of the structure of the metal. At the same time, it is claimed, great control over the grain-flow is obtainable by the extrusion process, by suitable proportioning the dimensions of the slug, the taper of the die and other factors. Typical grain-flow is shown in the rough "use" (B, Fig. 3) and in the finished valve blanks shown in Fig. 3, of which C and D are silico-chrome steel and D is DTD 49 B steel. The line tracings in Fig. 4 are made from Fig. 3 and show the grain flow rather more clearly than is possible in a reproduced photograph.

An important and valuable feature of the extrusion process is the nature of the pressure exerted by the dies during extrusion. It will be evident that it is a squeezing process resulting in knitting together the structure of the metal, and is in striking contrast to the bursting effect of the electric-upsetting process. This contrast is shown in Fig. 5, where an electrically upset "use" demonstrates an extreme example of the opening-up and bursting action on surface defects in the rod used. The other section in Fig. 5 is that of a valve blank made from a slug through which a $\frac{3}{16}$in. hole had been drilled before extrusion. It will be seen that the hole remains in the head and neck only as a vestige, while in the stem the hole has apparently closed-up completely and disappeared.

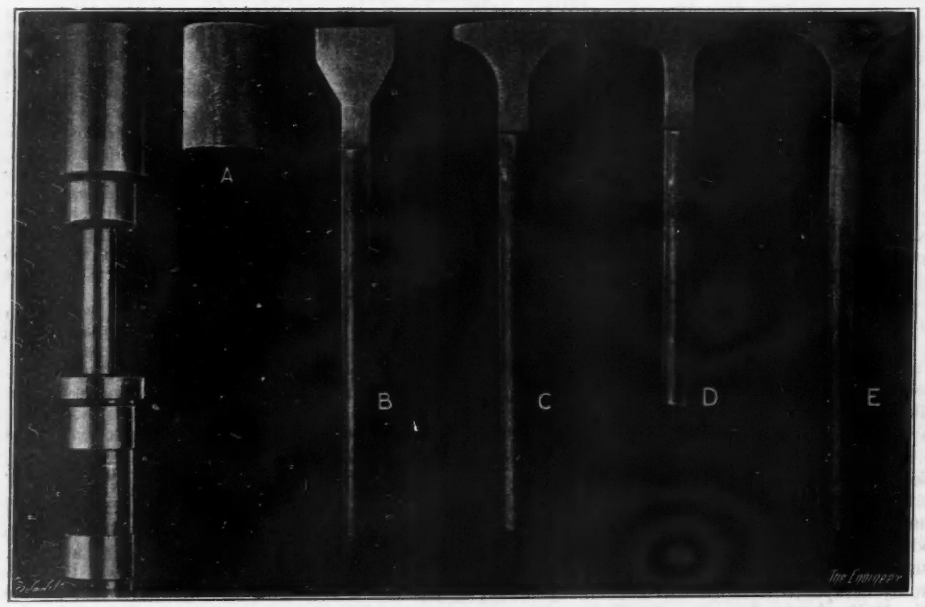
Much importance is attached by engine builders to the correct grain flow which is attained by the extrusion process. In Fig. 3 (C, D, E) the grain-flow has been adjusted to give a grain everywhere parallel to the working face of the valve, and this is accepted as good practice. Grain-flow which is at right angles or runs out to the working face of the

FIG. 5—ELECTRICALLY UPSET "USE" AND EXTRUDED VALVE

valve gives rise under certain conditions to pitting of the seat with minute holes. For valves of which the faces are to be subsequently stellited, alternative patterns of grain-flow are preferred by some manufacturers.

As worked by Daniel Doncaster and Sons, Ltd., which are the only manufacturers of valves in this country as yet operating the extrusion process, it is found possible to obtain production outputs amounting to some thousands of valves per shift, in contrast with the much smaller output of "goffed" valves, which is, moreover, limited by the volume of highly skilled labour available.

It may be mentioned, incidentally, that Daniel Doncaster and Sons, Ltd., are producers of large quantities of valves by all three processes and will continue to produce "goffed" valves for all duties, patterns and quantities for which this process is most economical and efficient, as well as electrically upset valves.



FIGS. 2 AND 3—SET OF EXTRUDING DIES AND—A TO E—STAGES IN THE PRODUCTION OF VALVES

FACTORY LIGHTING.—Some interesting figures were given in a paper on "Lighting for War-time Production" by Mr. H. Lingard at a special conference of the E.L.M.A. Lighting Service Bureau. He referred to an investigation carried out some time ago by a Government Committee into the relationship existing between illumination and accuracy of operation on fine detail work—typesetting by hand. It was assumed that daylight conditions provided the best working conditions, and it was found that the value of artificial light required to produce similar efficiency of operation was of the order of 20 foot-candles. Reductions from this intensity resulted in large decreases in output. At 7 foot-candles the output had dropped by 10 per cent., while the percentage of errors increased. When the lighting intensity was still further reduced to 2 foot-candles output was down by 25 per cent., while errors had more than doubled. It was also shown that three men working under an illumination of 20 foot-candles could do as much work as four men with only 2 foot-candles.

Rail and Road

CREOSOTE AS A FUEL.—As a result of successful experiments, the Halifax Corporation Transport Department is running a number of buses on a mixture of crude oil and creosote.

CLOSING OF RAILWAY IN EIRE.—The fifty miles long Letterkenny and Burtonport extension line of the Londonderry and Lough Swilly Railway Company is being closed down on June 3rd, and the passenger service on the Bridgend–Letterkenny section is being closed at the same time.

BANK STATION RE-OPENED.—With the recent re-opening of the Bank station, the whole of the protective works at underground stations has been completed by the London Passenger Transport Board, and through running by Northern Line tube trains between Moorgate and London Bridge stations has been resumed.

RAILWAY FITTERS FOR AEROPLANE WORK.—It is announced that under the Special Powers legislation of the Government, a number of fitters are to be transferred from the railway shops of the London, Midland and Scottish Railway at Crewe to the various aeroplane factories for the duration of the war.

RAILWAYMEN'S WAGE CLAIM.—At the conference in London on Thursday, May 23rd, between representatives of the three railway trade unions and the Railway Executive Committee, no settlement was reached on the union's claim for a further increase in wages of 6s. a week for traffic grades and £15 a year for salaried staff. The discussions were adjourned until an early date. It is understood that no definite offer was made by the Railway Executive Committee.

IMPROVEMENT OF BRITISH ROADS.—The annual report of the Roads Improvement Association states that the systematic modernisation of our road system was, after many years of propaganda, making particularly good progress in the early part of 1939. Most of these works were suspended on the outbreak of hostilities, but the approved schemes are being kept immediately available to provide work for the men who will need employment when peace returns.

ELECTRIFICATION IN SWITZERLAND.—The bulletin of the Swiss Association of Electrical Engineers describes the recently completed electrification of the Lucerne–Brienz section of the Brunig railway between Lucerne and Interlaken. The part of the line between Brienz and Interlaken has been electrically operated for some time, but on the Brienz–Lucerne section, owing to the severe gradients, two types of steam-operated rack locomotives have so far been employed. They have now been replaced by sixteen special electric locomotives adapted to work on both the ordinary and rack sections.

WORKMEN'S TRAINS ON SUNDAYS.—It was announced by the Ministry of Transport that following the Government's appeal for the continuous operation of engineering works and other establishments engaged on Government work, the main line railway companies and also the London Passenger Transport Board have arranged for the running of additional services on Sundays, both by road and rail. Workmen's tickets are being issued on weekdays and on Sundays, and are available on the production of an employer's certificate. On Sunday last, May 26th, transport facilities to the various establishments were available owing to the co-operation between the factory managements and the local railway officials, which in most cases were made in advance of the requirements.

LOCOMOTIVE BUILDING IN INDIA.—A report in the *Railway Gazette* states that there are indications that the Indian Railway Board will decide to accept the recommendations of the experts for the building of new broad-gauge locomotives at Kanchrapara, on the Eastern Bengal Railway, and the transfer of all heavy repair work thence to Jamalpur, on the East Indian system. This decision is expected to be taken before the meeting of the Standing Finance Committee for Railways in June; subject to the committee's approval, a demand for a supplementary grant may be made during the autumn session of the Legislative Assembly. Meanwhile, it is reported that preliminary arrangements are already being made to move the plant at present used for repair work at Kanchrapara to Jamalpur. This clearance will leave the former shops free for the most efficient layout of machinery and equipment required for locomotive building. It is also understood that preliminary designs are being prepared for the manufacture of jigs and fixtures required for new engine building.

A POST OFFICE UNDERGROUND RAILWAY.—An underground railway has been recently built in Zurich for the conveyance of letters and express packets, between the branch post office at the main railway station and the Sihl Post Office, the distance being about 1100 yards. The service is ensured by a driverless electric truck, which is set in motion by pressing a push-button on the main control panel. At the railway station terminus the truck runs on to a lift which comes into operation automatically and raises it to the level of the Post Office above. The order for the whole installation was placed with the Oerlikon Company. The railway is run off a three-phase 220 volt, 50 cycle supply. This current system presents the advantage that it obviates the necessity for converter sets or special reversing gear on the motor-truck. For reversing the direction of travel it is necessary to change over two phases of the supply. The truck is equipped with induction motors, so that its speed is nearly constant and practically independent of the load and gradient. The motor-truck has two axles. There are no springs, rubber rings being provided between the wheel hubs and the flanged rims. One of the axles is coupled through gears to a 3·5 H.P. three-phase induction motor; it gives the motor-truck a speed of 14·4 ft.-sec. The other axle is driven by a 1 H.P. motor, but only for running at low speed (0·98 ft.-sec.). The latter motor is brought into operation at the stations by means of an electro-magnetic coupling, controlled by a change-over switch. This change-over switch is actuated by a roller which comes on to a third rail provided in the station sections. The motor-truck is furthermore fitted with a mechanical brake, which is operated by spring force.

Miscellanea

WAR CHEMICALS PRODUCTION IN ITALY.—The Rome correspondent of the *Chemical Trade Journal and Chemical Engineer* reports that a special town—known as the "Chemical City"—is being built at Sorge Nel Lazio to house the country's entire research, training and manufacturing facilities for chemical warfare. It will cover an area of about 700 hectares and will have a permanent peace time population of 400.

THE PARLIAMENTARY AND SCIENTIFIC COMMITTEE.—At a recent meeting of the Parliamentary and Scientific Committee at the House of Commons it was decided in view of the grave situation which had revealed itself to hold regular weekly meetings in future to examine all ways by which a greater application of scientific knowledge could be applied to the conduct of the war in its various aspects and to bring these matters to the immediate notice of the appropriate Ministers.

ELECTRIC LIGHT FITTINGS EXPORT GROUP.—An Electric Light Fittings Export Group has been set up for the purpose of material control and co-ordinating individual effort to increase export business in electric light fittings, in furtherance of the National export drive. The Chairman of the Group is Mr. A. E. Iliffe, with Mr. Felix A. Rogers as Secretary. Membership of the Group is open to manufacturers in Great Britain of electric light fittings and accessories, who at present are exporting their products, or definitely intend doing so. Such manufacturers are invited to communicate with the Group at 36, Kingsway, London, W.C.2.

NAMING OF SCIENTIFIC INSTRUMENTS.—The rapid development of scientific instruments in recent years has caused a good deal of confusion in the nomenclature. Instances frequently occur when, owing to unfortunate nomenclature, it is not even realised that an instrument for some special purpose is actually in production; the trade name in such cases gives no clue to the purpose of the instrument. It is believed that much effort could be saved if the nomenclature of scientific instruments were put on a sound basis. A suggestion that there should be set up an authoritative body, to whom the proposed name for an instrument could be submitted for approval, is put forward in a recent article by Mr. J. W. Williamson (formerly Secretary of the British Scientific Instrument Research Association) in *The Journal of Scientific Instruments*, published by the Institute of Physics.

A SUBSTITUTE FOR MICA.—A bulletin of the United States Bureau of Mines describes the production of "Alsifilm," a substitute for split mica. For its manufacture raw bentonite is made into a two per cent. dispersion with water, and this is allowed to settle or is centrifuged to remove the coarser particles. The colloidal material is then either evaporated or concentrated in a supercentrifuge to a 6 to 8 per cent. gel, which has the consistency of smooth paste and so can be spread over a flat surface and then struck off to an even thickness by passing it under a knife. The moist film is next placed under a bank of incandescent electric lamps with infra-red reflectors, and films up to 4 or 5 mils thick are dried in about five minutes. Thicker films cause difficulty and at present the sheets are made separately in 3ft. lengths and widths of 18in or more. The final treatment is immersion in a hardening bath that renders the material water-resistant. Experiments have been made with both potassium hydroxide and lead acetate baths. The action is a base exchange, and although adding potash yields a product that more nearly duplicates the composition of the muscovite molecule, lead acetate is more generally used.

NASMYTH RELICS.—"Those," says the *Quarterly Bulletin* of the Newcomen Society, "who have read the autobiography of James Nasmyth, of steam hammer fame, know that when he retired from business in 1856, at the early age of 48, he went to live at Penshurst, a delightful spot in Co. Kent, where he spent much time in his engineering workshop and in astronomical pursuits. Some years after his death, in 1890, his effects were dispersed, and a few of the objects found their way, appropriately, to the Science Museum, South Kensington, London. A few more came into the possession of an old servant of the family, and these have just come to light. We can only mention two objects: one is a model of Nasmyth's steam hammer engine, 1848, that found many applications in pumping, blowing and marine work. The other is a screw originating hand lathe. This has a double V-bed to accommodate one of half a dozen lead screws to actuate a slide rest, while the blank to be cut is between centres. Its date is not known, but it has a family resemblance to a lathe made by Maudslay early in the nineteenth century and, curiously, to one sketched by Leonardo da Vinci in the sixteenth century. The Society is making an effort to preserve these objects."

INVESTIGATIONS ON POZZOLANAS.—Pozzolanas are siliceous materials, such as diatomaceous earths or certain volcanic dusts, containing constituents which, at ordinary temperatures, combine with lime in the presence of water to form compounds of low solubility and possessing cementing properties. Their use in lime mortar and in mixtures with Portland cement has been common practice abroad in preparing concrete for work underground or in water and particularly where resistance to attack by chemical agents is desired. The little use made of pozzolanas in this country is ascribable in part to the absence of any suitable natural deposits of these materials in Great Britain. For some time, however, investigations have been undertaken by the Building Research Station of the Department of Scientific and Industrial Research, in co-operation with certain interested companies, to explore the production, properties and utilisation of artificial pozzolanas manufactured by the burning of suitable clays and shales. The results of some of this work are described in *Building Research Technical Paper No.* 27, "Investigations on Pozzolanas—I. Pozzolanas and Lime-Pozzolana Mixes," published by H.M. Stationery Office, price 1s. The report deals with mixes of pozzolanas with lime; mixtures of Portland cement and pozzolanas will be considered in a further report. It is shown that artificial pozzolanas can be produced from burnt clays and shales equal in properties to good natural pozzolanas.

Air and Water

FRENCH NAVAL LOSSES.—The French Government has announced the loss of the 1380-ton destroyer "L'Adroit," the 540-ton submarine "Doris," and the supply ship "Le Niger."

FACTORY SECURITY.—The Minister of Aircraft Production, Lord Beaverbrook, has appointed Admiral Sir Edward Evans to take charge of the local protection and security of the organisation of all factories engaged on aeronautical work and the aerodromes attached to them. Sir Edward's headquarters will be at the Ministry of Aircraft Production, Millbank, S.W., and he will at once be visiting various centres. He has the full authority of the Ministry.

NEW LIFEBOATS FOR THE EAST COAST.—The Royal National Lifeboat Institution announces that two new motor lifeboats have left the building yard for service on the East Coast, at Aldeburgh, Suffolk and Filey, Yorkshire. Both boats are of the light Liverpool type specially designed for launching from the beach. They have a length of 35ft. 6in., and a weight of 17 tons. Their design is such that should a sea break on board the boat can free itself in 12 seconds. Since the beginning of the war the Royal National Lifeboat Institution has put into service around our coasts no less than thirteen new motor lifeboats.

THE AMERICAN SUBMARINE "SQUALUS."—The United States submarine "Squalus," which was recovered after sinking off the New Hampshire coast in May, 1939, has been reconditioned and recommissioned under a new name, the "Sailfish." It will be remembered that 33 of her crew were rescued by means of a diving bell and that after four unsuccessful attempts she was raised to the surface in September last. A detailed description of the operations involved in the submarine's salvage was given in our issues of December 15th and 22nd, 1939. The reconditioning of the vessel is reported to have cost nearly one and a half million dollars.

PRODUCTION OF AIRCRAFT EQUIPMENT.—Lord Beaverbrook, the Minister of Aircraft Production, announces that he has appointed an Emergency Committee to deal with the production of aircraft equipment. Mr. C. J. Stewart is Chairman, and Sir Alan Gordon Smith and Mr. F. J. E. Brake are members. Mr. Stewart has been Director of Civil Research and Production at the Air Ministry since 1938, Sir Alan Gordon Smith is Managing Director of S. Smith and Sons (Motor Accessories), Ltd. and Mr. F. J. E. Brake, Managing Director of Creed and Co., Ltd., and a Director of the International Marine Radio Company, Ltd. The Committee has full authority.

SHADOW AERO ENGINE COMMITTEE.—Lord Beaverbrook, the Minister of Aircraft Production, regrets to announce that Lord Austin has retired from the chairmanship of the Shadow Aero Engine Committee, which he has held ever since its inception over four years ago. Mr. W. E. Rootes is now the chairman. Lord Austin has been largely responsible for co-ordinating the work of six shadow factories. He directed the Austin Company's aircraft factory, and the Company placed the capacity of the motor-car plant at the disposal of the Government for aircraft work. He has generously given his personal services, and the vast resources of various undertakings associated with his name have been at the disposal of the country

ELECTRIC PROPULSION OF TUGS.—According to experiments carried out by the Central Institute of Research on River Transport on the old Ladoga Canal in Russia, the fitting of tugs with electric propelling motors, taking current by means of a sliding shoe from power lines on the canal bank, has shown a considerable reduction in first cost as well as lower overhaul and repair costs. The control of speed and the manœuvring of the tugs is also easier than with steam tugs, while the cost of electric traction is stated to be only about half that for steam propulsion. As a result of the successful experiments carried out the Commissariat of River Transport has instructed the Institute to prepare a scheme for electric traction on the New Ladoga Canal.

SKILLED FITTERS AND TOOLROOM WORKERS.—Mr. Ernest Bevin, the Minister of Labour and National Service, makes an appeal to all owners of maintainance workshops with regard to skilled fitters and toolroom workers who may be engaged in such establishments. Many of such workers might, Mr. Bevin suggests, be released either permanently or temporarily for work on more essential production. Firms, Mr. Bevin suggests, might discuss the matter with their skilled workers and tell the local Labour Exchange what they would be willing to do. Even a temporary loan of skilled labour is important at the present time, and employers are asked to consider whether some of their maintainance work cannot without serious danger be postponed, so that the skill of their men may, if required, be available for vitally urgent work in the national interest.

BRITISH NAVAL LOSSES.—The Secretary of the Admiralty regrets to announce the loss of the destroyer H.M.S. "Wessex" as the result of air attacks while engaged in operations off the French coast. The "Wessex" was one of the 1100-ton "W" type destroyers built by Hawthorn Leslie in 1918 under the Emergency War Programme. She had a length overall of 312ft., a beam of 29¼ft. and a mean depth of 10ft. 10in. Her propelling machinery comprised all-geared Brown-Curtis turbines taking steam from three Yarrow oil-fired boilers. With an output of 27,000 S.H.P. the "Wessex" had a designed speed of about 34 knots on light load draught and about 31 knots on deep load draught. It is also announced that H.M. minesweeping trawler "Charles Boyes" has been sunk by an enemy mine. The loss has also been announced of the 9550 ton cruiser "Effingham," as a result of damage sustained through striking a rock off the Norwegian coast, and the minelayer "Princess Victoria" through striking a mine. The "Effingham," which was completed in 1925, was one of the improved "Birmingham" class of cruisers and her armament included nine 6in. guns. The "Princess Victoria" was originally a passenger and motor-car carrier belonging to the London, Midland and Scottish Railway Company, and was only completed in July last year.

THE GYOBYU RESERVOIR WORKS, RANGOON, BURMA

MESSRS. BINNIE, DEACON, AND GOURLEY, WESTMINSTER, CONSULTING ENGINEERS

(*For description see page* 488)

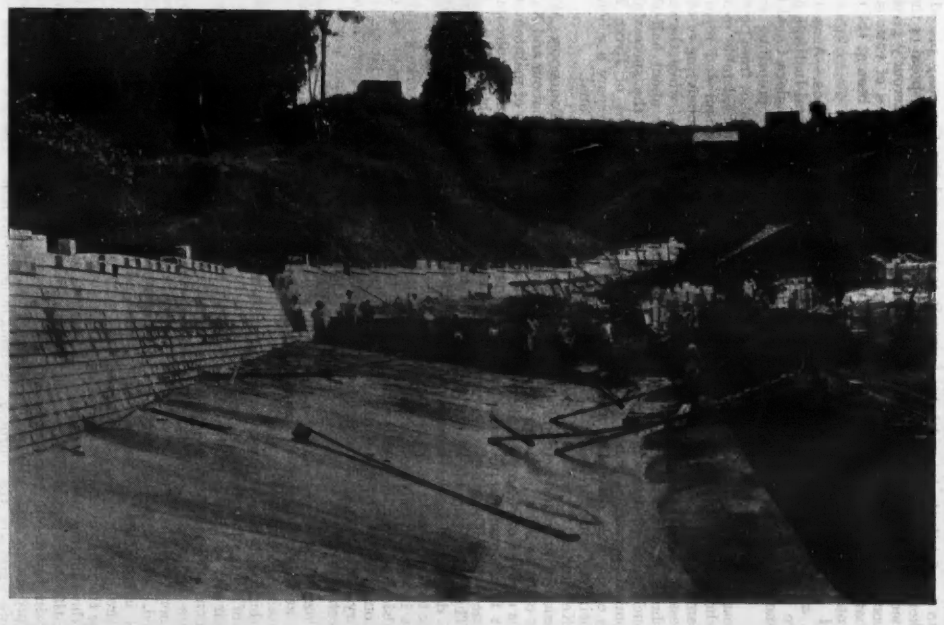


FIG. 5—OVERFLOW CHANNEL UNDER CONSTRUCTION
FIG. 7—DOWNSTREAM SLOPE OF DAM

FIG. 6—CORE WALL AND UPSTREAM EMBANKMENT
FIG. 8—VALVE TOWER AND ACCESS BRIDGE

The Engineer

MAY 31, 1940

VOL. CLXIX No. 4403

Contents

THE ENGINEER, May 31st, 1940 PAGE

A SEVEN-DAY JOURNAL ... 487

LEADING ARTICLES—
"THE ENGINEER" RETURNS TO LONDON ... 497
WAR INVENTIONS ... 497
SOME AERONAUTICAL EXPERIMENTS IN AMERICA ... 498

SPECIAL ARTICLES—
ARMAMENT OF THE HEINKEL HE.112 FIGHTER MONOPLANE (Illus.) ... 489
MASTERING MOMENTUM IN TRANSPORT. No. III. (Illus.) 500
QUEENS MIDTOWN TUNNEL, NEW YORK. No. I. (Illus.) 491
WATER SUPPLY OF RANGOON, BURMA. No. I. (Illus.) ... 488

IMPROVED EFFICIENCY OF DREDGER PUMPS. (Illus.) ... 502
MEASUREMENT OF EARTH PRESSURE. (Illus.) ... 504
NEWCOMEN SOCIETY ... 493
NEW FORM OF STEEL BUILDING. (Illus.) ... 502
REGULATION OF LABOUR SUPPLY ... 506
SKIN TROUBLES AND MACHINE TOOLS ... 501
VALVE PRODUCTION BY THE EXTRUSION PROCESS. (Illus.) 494

LETTERS TO THE EDITOR—
"SIXTY YEARS AGO—LONDON'S WATER SUPPLY" ... 499
TURBINE LOCOMOTIVE PERFORMANCES ... 499
A GRAPHIC METHOD OF OBTAINING LOGARITHMIC MEAN TEMPERATURE DIFFERENCES ... 499

LITERATURE ... 498

OBITUARY—
H. O. BALDRY ... 498

NEWS AND NOTES—
AIR AND WATER ... 495
BRITISH PATENT SPECIFICATIONS. (Illus.) ... 506
BRITISH STANDARDS INSTITUTION ... 504
CANADIAN ENGINEERING NEWS ... 503
CATALOGUES ... 506
MARKETS, NOTES AND NEWS ... 505
MISCELLANEA ... 495
PERSONAL AND BUSINESS ANNOUNCEMENTS ... 506
RAIL AND ROAD ... 495
SIXTY YEARS AGO ... 499

NOTICES TO READERS

IMPORTANT NOTICE

EDITORIAL AND PUBLISHING

The Engineer, which has been printed since the end of August by William Clowes & Sons, Ltd., Beccles, will in future again be printed by G. Reveirs Ltd., 10 Rosebery Avenue, E.C.1, commencing with the next issue, June 7th.

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The Engineer,
28 Essex Street,
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London, W.C.2

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CHANGE OF ADDRESS

**** Will Subscribers please note that in all advices regarding changes of address it is necessary to have* **both the old and new addresses**, *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

Postal Address: "The Engineer," 28, Essex Street, Strand, London, W.C.2.

Telegraphic Address: "Engineer Newspaper, Estrand, London." Telephone: CENtral 6565 (10 lines).

"THE ENGINEER" RETURNS TO LONDON

THE ENGINEER is returning to London. Our next issue, that of June 7th, will be printed at Rosebery Avenue by George Reveirs, Ltd., and published from 28, Essex Street, Strand, W.C.2, the address of our headquarters. Last September, as hopes of averting war with Germany were rapidly waning, it was decided, in the light of the official view then reigning that any war was likely to be opened by an aerial "blitzkrieg" directed against London, that the printing and publishing of THE ENGINEER should be transferred to the country. By arrangement with and by the courtesy of George Reveirs, Ltd., a firm which had up till then uninterruptedly printed THE ENGINEER since its first inception in 1856, an agreement had been reached some months earlier, that, should evacuation ever become necessary, William Clowes and Sons, Ltd., should undertake the printing in their works at Beccles. Thus last September the headquarters of the advertising and publishing departments of THE ENGINEER were transferred to Beccles. The Essex Street offices retained their importance as editorial headquarters. Now a return is to be made to London. But we should be sorry to leave Beccles without putting on record our indebtedness to the company that has been our host. It was no light thing, even for so well-established a firm, to be called upon relatively suddenly to adapt its organisation to the production of a publication of such size as THE ENGINEER with whose predispositions it was not well acquainted. That, though hitches did occur at first, as indeed in the circumstances they were bound to occur, none of them was of a serious nature, is a tribute not only to the skill and organising ability of those in responsible positions, but also to the good-humoured friendliness with which employees of the firm greeted the strangers who had come down from London. For all those connected with THE ENGINEER who have had the fortune to be stationed at Beccles there will be mingled with the pleasure of working again with old and well-tried friends regret that the change must cause an interruption of other friendships, recently formed, but none the less strong for that.

War Inventions

THERE is, we are proud to say, no nation which has to its credit a greater number of mechanical engineering inventions of primary importance than this land of ours. It is unnecessary to enumerate them; they are too well known to need that. We recall them now because they are unchallengeable evidence that we are by nature an inventive people. It is true that in many instances, too many perhaps, we have allowed ourselves to rely upon the work of foreign inventors. But that has generally been done for business and economic reasons and hardly alters the fact that when an invention is wanted, an inventor of it will be found in our midst. The power and ability are here even though they are not always given an opportunity to reveal themselves. Under the stress of war this inherent inventiveness is stimulated. Let something be demanded and it will, surely, be found. It is worth remembering that in the last war four at least of the outstanding novelties originated in this country—the Stokes trench mortar, the Mill's bomb, the tank and the paravane. In the present war no radically new invention has yet been employed by the enemy, whilst British engineers have to their credit the degaussing girdle which in a few weeks nullified the magnetic mine. We have little or no doubt that as the war proceeds history will repeat itself and that this country will again produce inventions that will vitally affect the ultimate victory.

We are not satisfied that this natural inventiveness is being exploited as fully as it might be. We are aware that a great number of inventions are received every week by the three Services and that a Council of scientists under the Chairmanship of Lord Cadman exists and acts in an advisory capacity on Scientific Research and Technical Development. But neither this Council nor the Services have, as far as we can ascertain, made any attempt to tap the inventive capacity of the nation as a whole. We understand that the primary function of the Council is to transmit to the Admiralty, the War Office, or to the appropriate Ministry any inventions which it may deem worthy of consideration. We presume, furthermore, that the Services look for inventions within their own borders or take specific problems to manufacturers. Whilst admitting at once that those are the most likely sources, yet it must not be forgotten that many a good invention—remember the Stokes' gun and the Mill's bomb—has sprung from an unexpected quarter. In an emergency like the present the search should be broadcast and should not be too strictly limited to particular fields. The response to that assertion may be, will certainly be, that all and sundry are free to send in their ideas to the proper authorities and that they will be given courteous and careful consideration. Agreed; but that is not the way to look for new inventions. The first essential is to state the problem as completely as possible, and the second, no less important, to indicate, also as fully as possible, the controlling conditions. The Services seem to have set their faces against that practice. Their argument appears to be that we must not let the enemy know how much we know about his methods and devices and must not show him that we are busying ourselves about means of countering them. Obviously the inventor is hampered almost to the point of impotence by this restriction. He neither knows what is wanted nor what conditions must be considered in an attempt to meet the want. Take as a hypothetical case the need for a more effective projectile for use against aeroplanes. Before the inventor could begin his work he would have to know the bore of the available guns, the weight of the projectiles, the ballistic properties of the guns, the range desired, the susceptibility of aeroplanes to particular kinds of damage, the nature of the attack that it is desired to repel, and a dozen other details which would vary according to the nature of the invention. The "casual" inventor may inform himself with a little trouble about some of these things, but about others he will find the greatest difficulty in getting any information at all. We have taken this example because it happens to be representative of a grave present need, but any other in the whole field of warfare, and there are dozens of them, might have been selected. In nearly all of them the inventor who is not "in the know" is hampered by the caution and reticence of the Services.

Now, whilst we do not propose to challenge the right of the Services to decide what may be and what must not be disclosed, we are convinced that every possible source of invention should be tapped and that serious damage may result from a neglect to do so. The problem, therefore, is to discover some means by which the field of invention may be extended without broaching the secrecy which is considered vital by the Services. There are, we think, several ways in which that might be done and we advance one, merely as an example. Let each of the major Institutions set up a small and carefully selected committee for the Encouragement of War Inventions. These committees would keep in close and constant contact with the Services and would be given confidentially every available particular about needed inventions. Nothing should be hidden from them and any questions they asked should be answered as fully as possible. The committees thus provided would cast about for the type of inventor likely to be able to provide what was required in any given instance and invite him to submit proposals. With its knowledge of the conditions it would be able to see at once if the proposal had hopeful elements. If it had, the inventor would be invited to discuss the matter with the committee, which would then reveal to him such details of the conditions as were necessary to enable him to bring his proposal to a practical form. If it had not the desired qualities and characteristics, the committee would advise the inventor that it failed to meet the conditions prescribed and would indicate broadly in what respects it did so. This

sketch is no more than a suggestion of a line of approach to what everyone will agree is a vital need of the day—the encouragement as energetically as possible of inventions which may be used against the enemy both in attack and defence. That it has certain failings we are aware and we expect to be be told that all we have proposed is already being done directly by the Services. As far as the failings are concerned we are confident that they can be overcome in a national emergency; as for the rest we are clear in our own minds that reticence is hampering invention.

Some Aeronautical Experiments in America

THE curtain has descended on almost all publication of the results of aeronautical research in Europe, and even the United States authorities are less generous in publicity than they were. Nevertheless we have in the recently published annual report of the National Advisory Committee for Aeronautics, of Washington, a remarkably full statement of the present position of the art. And publicity or no publicity, science—even aeronautical science—is sufficiently international for the problems currently studied in one country to be exceedingly like those studied in all others that take the matter equally seriously. It is this last consideration that makes the American report so interesting, since although it purports to deal only with its own affairs it cannot help being a mirror of what is in men's minds elsewhere. Some of the items under investigation are of especial interest at the present time. Though the language used is cautious, it is evident that high hopes are placed on the achievement in the near future of a quite startling improvement in the aerodynamic efficiency of aerofoils. This high hope is the outcome of certain wind tunnel tests in which transition from laminar to turbulent flow was found to be long delayed, leading to a reduction of two thirds in the drag force. There remains, however, in America as elsewhere, the exceedingly hard task of applying this favourable, but probably critical, condition to full scale operation. Only slightly less important is the search for a better anti-knock fuel and it appears as though with a substance to which the name "triptane" has been given, an octane value as high as 108 has been reached; but, no doubt, at some considerable sacrifice in economy as measured in cents per gallon. On the other hand, the additional speed attainable in high performance aircraft is an advantage worth paying for.

One cannot but feel admiration for those investigators in America, as elsewhere, who have essayed the exceedingly difficult task of co-ordinating the strength factors of flying boat hulls. It is not hard to measure the deceleration of the hull—or of particular parts of it—during a heavy take-off or landing, and with care it is possible to record the values of the rapidly changing pressures on the skin of the hull itself; but even when satisfactory agreement is obtained between the one set of measurements and the other, it is no easy matter to see what effective guidance can be given as a result to the flying-boat designer. The wave of pressure that flashes through the skin of the hull during these critical instants is of such localised intensity and of such exceedingly transitory duration that it is difficult to predict just what effect it can have on material of given elastic qualities. On the whole it seems as if the effect of high stresses is cumulative and what may be withstood ten times will not necessarily be withstood a hundred. Moreover, there are three factors of equal importance to be remembered when one is giving consideration to such matters. On the one hand there is the risk of failure during a heavy landing of the superstructure itself (wings and engine nacelles), there is the bursting effect on the skin, and there is, in addition, the effect on the longitudinal and cross-members of the framework itself. If in course of time a drastic change in the hull form itself should arise, the problem of stress distribution will have to be entirely resurveyed; but large flying-boats are so expensive that a certain measure of caution in making radical changes in design is but natural. In America, as elsewhere, much effort is being expended in the hope one day of using synthetic resins for really important parts of aircraft, even those parts which have to carry high stress. It may be long before the enthusiasts for this hoped-for advance come within sight of their goal, but despite the difficulties encountered progress is reported. The United States Government has decided to create a new research laboratory in the west in addition to the famous one at Langley Field in the State of Virginia. The new laboratory will be at Moffett Field, California, and for it a provision of ten million dollars is being made. This site was chosen from no less than fifty-four alternatives and in view of the rapid growth of the aviation industry in the Western States it is likely to receive a cordial local welcome and to be set speedily to work. In its future plans, the committee includes also the provision of an engine research laboratory, in order to make headway against what it frankly terms the superiority of certain liquid cooled engines produced overseas.

At the present time the United States Government is known to have what, on any dimensional basis, must be described as the most extensive plant for aeronautical research to be found anywhere in the world—though we have seen a reference to a possible high bid from Japan to rival the great full-scale wind tunnel at Langley Field—and credit is due to the American authorities for the generous way in which the aeronautical needs reported by the Research Committee are met. One change, however, in the American organisation which all who knew him will regret, is the retirement of the Chairman, Dr. Joseph Ames, long President of the Johns Hopkins University at Baltimore. Dr. Ames had the duty sometimes to lead his committee through lean and difficult years, but at all times he led it with vigour and distinction. He was a frequent visitor to England and seemed always to appreciate the courtesy of being invited to attend meetings of our own Aeronautical Research Committee. In view of the considerable aircraft building now proceeding in America for the strengthening of the Allied Air Forces in Europe, we have especial reason to welcome American activity in this field of research.

Obituary

H. O. BALDRY

WE regret to have to record that Mr. Henry Osborne Baldry, one of the oldest civil engineering contractors in Great Britain, died at St. Mawes, Cornwall, on April 24th. He was born in 1852, at Boston, Lincolnshire, and was the son of James Danford Baldry, who was associated with the late Sir Benjamin Baker and Sir Henry Fowler.

Mr. Baldry was educated at King's College, London. During the first thirty years of his business career his sole partner was the late John Eardley Yerburgh, but in 1910 they were joined by William Haines Hutchinson, M. Inst. C.E., and thereafter the business was carried on under the title of Baldry, Yerburgh and Hutchinson, Ltd.

During the period of Mr. Baldry's long and active career many and varied works of importance and magnitude were undertaken, including the Canada Wet Dock No. 3 and the Herculaneum Dry Dock No. 4, both at Liverpool, a large storage reservoir for Swansea, and a larger number of railway works, among which may be mentioned the main line of the Great Central Railway from Chesterfield to Newstead, including a tunnel 1000 yards in length, the Selby and Goole Railway for the North-Eastern Railway Company and the Mansfield Railway, with branches to numerous Nottinghamshire collieries, forming a direct route between the Great Central main line at Kirkby, Nottinghamshire, with Immingham Docks and the East Coast. The most ambitious work of his career was carried out by his company on the construction of two sections of the Welland Ship Canal for the Dominion Government of Canada between Lake Ontario and Thorold, comprising the breakwaters to the canal entrance at Port Wellar, Lake Ontario. The work of these two sections called for approximately 8,000,000 cubic yards of excavation and over 750,000 cubic yards of concrete in locks, weirs &c.

During the Great War Mr. Baldry's company was engaged upon the construction of railways and organisation of supplies for H.M. Office of Works and Ministry of Munitions at Henbury, Gillingham, Clipstone, Skipton, Cannock Chase, &c., and the felling and supply of timber pit-props in Nottinghamshire, Yorkshire and Norfolk. Mr. Baldry took an active interest in the introduction into Great Britain of cold asphalt surfacing on highways. He was a member of the Institution of Civil Engineers and a Justice of the Peace for the County of Bedfordshire. In the Federation of Civil Engineering Contractors he held office for many years and was one of the trustees of the Federation's invested funds.

Literature

Engineering Reorganisation. By James J. GILLESPIE. Sir Isaac Pitman and Sons, Ltd., London. 1940. Price 12s. 6d. net.

THIS is not a book for the engineering student so much as for the man who has acquired an extended knowledge of works organisation, and has already formed his ideas on the subject, but at the same time is inspired by the desire to "go one better" than he has hitherto, and to reorganise his business with a view to obtaining increased efficiency. To such we commend a volume which is suggestive and thought provoking; indeed many of the suggestions are made in the form of questions which are left for the reader to develop. For example, in dealing with the reorganisation of the drawing office, many questions are raised such as: "Is the method of showing dimensions standard?" to quote one at random. Engineers will find that the majority of these queries raise a chain of thoughts which are likely to be productive of useful changes in the business.

We find no hackneyed phrases, no stereotyped signposts to an easy success, but much commonsense. We have not proceeded far in reading before we are recommended to make a thorough investigation of all the facts and data at our disposal before beginning reorganisation, and we are informed that "no ready made techniques should be applied." Unexplored theory gives place to acquired practical experience, and perhaps the keynote to the author's approach to his problems lies in his contention that "industrial management is a form of personal conduct, the effectiveness of which is dependent on the interplay of the situation to be managed with the physical, moral, mental and emotional characteristics which the manager brings to the service of industrial effectiveness." Too often the human element is relegated to a back place. We cordially agree with Mr. Gillespie when he points out that the manager often fails lamentably by his not being capable of delegating authority. It may often be easier to try to do a thing oneself, but the practice eventually leads to disaster. On the other hand, a case is cited where a "mutual trust drive" led to a brightening up of the whole organisation. While still considering the human element we are asked, "Do the top executive officials set an example of courtesy and sincerity to those subordinate to them?"—a question worthy of consideration.

All the main functions of organisation are touched on, including management, planning, ordering, research, standardisation, quality control, inspection, purchasing, maintenance, ratefixing, processing, estimating, costing and finance, and there are also investigations of the drawing office, the laboratory, the gauge and tool department, and the various shops, a separate chapter being devoted to each function, while other chapters are concerned with more general discussion.

Broadly speaking, Mr. Gillespie is so open minded that he does not dogmatise, and so he tends to disarm criticism, but where he is emphatic we usually are prepared to endorse his views, as, for example, that inspection should always be a part of planning, that inspection cannot function effectively under the works or production manager, that estimating and costing should never be under the same control—to instance a few. Some of his remarks are perhaps unduly scornful of the text book and the theorist, and he reveals his personal outlook when he asserts that in the tool room "theory . . . must give place to sound practice." We should rather say that theory must be supported by practice. In discussing the best situation for the stores, he suggests that given plenty of available land and plenty of cash the stores could be set out to the text book ideal, but in most factories each case must be treated on its own merits, and in the end the result will probably be a compromise.

Phases of management that are often overlooked receive the author's attention, and we are glad to

notice that he stresses the value of planned maintenance, for we are convinced that the proverbial "stitch in time" can be applied with much profit to machine tools and plant generally, with a result that many unnecessary breakdowns and consequent losses of output are avoided.

Among other remarks of the author we notice with interest his contention that to ensure adequate quality control it is highly desirable to make officials "gauge conscious"—a term that implies a good deal, for efficient gauging can only be relied upon when the gauges themselves have the care bestowed upon them which they deserve. Again he puts his finger on another sore point when he alludes to the "fed up" state of affairs that so often arises between the works and the drawing office, when the former ruthlessly overrides the latter, and "gets away with it." In the past we have had occasion to draw attention to the necessity for a careful study of the waste that occurs in many engineering works, and we are interested to read in connection with the salvage of material that Mr. Gillespie has had personal experience of a company which lost £800 in a year by mixing its swarf!

We have spoken of the author's open mindedness, but in one direction he definitely waxes cynical and is perhaps unduly harsh—that of the efficiency expert, for he says that "the continual nuisance in general engineering works is the time and motion study fanatic who specialises on Bedaux or on something like it and knows as much about shop practice and shop psychology as a duck knows about the quantum theory." Here is one of the few ruthless statements in a very fair survey of a big problem, but we believe there is much truth in the assertion that "although organisers and efficiency experts do not in writing say so, the truth is that a large part of an organiser's work is really the integration of existing ideas into a logical whole and the selling of these ideas to the directorate." To our mind this does not necessarily belittle the work of the efficiency man, but it must always be borne in mind that he is normally accorded more power than the shop executive.

We should like to touch on such subjects as bonuses for stores labour and the fact that people who are keen on it "fail to realise the important part played by honesty and dependability"; and on the advisability of using normal rather than current overheads for budgeting; and on the importance of cost control for efficient sales methods—but our space has gone.

We must, however, congratulate the author on his boldness in assessing the staff required for each of the main functions as definite percentages of total personnel. We hope to try out his figures in different organisations as opportunities arise.

Engineers and administrators will thoroughly enjoy this book, the reading of which will not be without profit.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

"SIXTY YEARS AGO—LONDON'S WATER SUPPLY"

SIR,—I have read with interest the article headed "Sixty Years Ago. London's Water Supply," in THE ENGINEER, dated May 17th, 1940. As a matter of history, I should like to challenge some of the inferences implied in the article.

Nearly a hundred years ago my own family was first closely associated with the water supply of the Metropolis, and remained so until the death of my father in 1918. It is wrong to state that the fire brigade had no understanding with the water companies, because, so far as the south of London was concerned, from about 1885 until the formation of the Metropolitan Water Board in 1904, most thorough co-operation existed, and this was largely due to the complete understanding between Sir Eyre Shaw, the then Chief Officer of the fire brigade, and my father. This organisation at first included telegraphic communication between the headquarters of the fire brigade and certain of the works, and later this was extended by means of the telephone. Turncocks attended all fires, and, for the larger fires, Divisional Engineers attended and frequently the Chief Engineer took control personally.

From about 1885 until 1904 very great improvements were made in the works of the companies, including the construction and putting into operation of large storage reservoirs, holding some thousands of millions of gallons, many acres of filter beds and large pumping stations.

An extensive inter-communication scheme between the companies was designed and put to work by the transfer of certain of the works of the Southwark and Vauxhall Water Company to the inter-communication scheme. These works comprised pumping stations, reservoirs, and the laying and connecting up of mains inter-connecting the groups of companies north and south of the Thames. In fact, the whole of the main outline of the present water supply scheme for London was prepared before the companies were transferred to the Metropolitan Water Board.

It may further be stated that before the companies were taken over practically the whole of the area supplied was on constant, and not "intermittent," supply, and high pressure fire service had been provided for fire hydrants.

J. D. W. RESTLER.
(Lieut.-Colonel)

159, Palace Chambers, Westminster,
May 21st, 1940.

[We fully agree that before the old water companies were taken over in 1904 many great improvements had been made in London's water supply. Our note, however, referred to 1880, five years *before* the date mentioned in Col. Restler's second paragraph. The picture outlined in our note may be supplemented by the following *verbatim* quotations from our issue of May 14th, 1880:—"The Fire Brigade, which is nothing without water, does as it best can without any attempt to come to an understanding with the water companies. . . . A fire brigade which knows nothing of the water companies seems a curious institution for putting out fires." Referring specifically to co-operation between the fire brigade, the water companies and the police, a Select Committee in 1877 reported that "the statutory arrangements for the extinction of fires in the metropolis . . . are not such as to furnish adequate protection to life and property." If the lack of co-operation between the fire brigade and the police can be taken as a measure of the co-operation between the fire brigade and the water companies then evidence is not wanting to show that the position was almost chaotic—a word which we ourselves actually used in the issue named to describe it. We mentioned, for instance, "the recent fatal fire at Aldersgate Street when a policeman ran for the fire-escape and found it chained and padlocked, the key being in the possession of a fireman not then on duty." Improvements were admittedly in hand, but it cannot be said that in 1880 they were fully effective. Intermittent water supply was still the rule in many large areas of London. High pressure street hydrants were engaging attention but few, if any, had actually been installed. In 1880 "the first of the new street fire alarms," to quote from our issue of May 7th of that year, had been erected "in Ludgate Hill and other streets." The device was described as consisting of a circular box on an iron pillar, the box containing "an electric apparatus" by means of which the police, furnished with a key for opening the box, could communicate with the nearest fire station. We feel sure that on further examination Col. Restler will find that all the great improvements to which he refers came to fruition after 1880, and that they were largely inspired by the public unrest, which we—in common with other journals—voiced in and about that year.—ED., THE E.]

TURBINE LOCOMOTIVE PERFORMANCES

SIR,—I was very interested to read of Mr. Livesay's experiences on the footplate of the L.M.S. turbine locomotive, and in connection with his account two points arise; the first concerns the control of the locomotive, and the second the riding.

Mr. Livesay states frequently that another nozzle was brought into action, and at other times one was cut out, and so on. Changing from one to two nozzles thus at first sight appears like suddenly doubling the amount of steam fed to the ahead turbine. Yet from the even speed maintained I cannot believe that this is so. My own extensive experience on the footplate has shown that to maintain such a speed the cut-off changes in a reciprocating engine need to be very slight, 15 to 18 per cent., for example, not 12 to 24 per cent., at one swoop. On a reciprocating locomotive working with a full-open regulator an increase of 5, or even 3 per cent. makes a big difference in the power developed, and from a sudden change from one to two nozzles on the turbine I should expect a positive leap in the speed, and the coal consumption! Perhaps Mr. Livesay can explain how the fine adjustments of power output are obtained from the six nozzles.

As to the riding it is extremely difficult to relate the behaviour of any particular locomotive, as a vehicle, to features in the design. Again quoting from my footplate experience I have found very surprising differences in the riding of individual members of the same class, and moreover locomotives with an approximately equal mileage since the last visit to plant. One will be as steady and smooth as a dining car, another will roll like a ship in a storm. The balancing of modern engines is such as to have very little effect upon the riding; the main factor in this respect seems to be the springing, and this would appear to be borne out by Mr. Livesay's experience on the L.M.S. Turbomotive.

O. S. NOCK.

Chippenham, Wilts.
May 20th.

A GRAPHIC METHOD OF OBTAINING LOGARITHMIC MEAN TEMPERATURE DIFFERENCES

SIR,—With regard to a letter by R. H. Parsons in your issue of May 17th, on "A Graphic Method of obtaining Logarithmic Mean Temperature Differences": owing to the difficulty of construction and reading, this does not give very accurate results when both differences are high.

There are some half-dozen different charts giving log m.t.d. Why use a chart when most draughtsmen are now in possession of a log-o-log slide rule? Having given D and d the largest and smallest temperature differences, find the ratio $\frac{D}{d}$, and the difference $D-d$. Set the cursor to $\frac{D}{d}$ on log-o-log scale, bring $D-d$ on the "C" scale under the line of cursor, shift cursor to 2·72 "(ϵ)" on log-o-log scale, and read the log m.t.d. on "C" scale under the line of cursor.

Sometimes the "C" scale, when set, does not appear under 2·72, in which case shift the cursor to the end of the "C" scale, then bring the other end of the "C" scale under the cursor, then move cursor to 2·72 and read as above.

G. C. HODSDON, M.I. Mech. E.

Dartford, Kent.
May 20th.

Sixty Years Ago

PERKINS' HIGH PRESSURE ENGINES

IN our issue of May 28th, 1880, we published some particulars of the iron yacht "Anthracite" of 70 tons gross register which was about to start on a voyage from Falmouth to New York under steam. The "Anthracite" was built by Schlesingar, Davies and Co., of Wallsend, and had a length of 84ft., a breadth of 16ft. and a depth of 10ft. Her engines and boilers, on the Perkins' system, were supplied by Hawks, Crawshay and Sons, of Gateshead-on-Tyne. The engines were three-cylinder compound working on two cranks. The high-pressure cylinder had a diameter of 8in. and was single-acting. The medium pressure cylinder, also single acting, had a diameter of 16in. The low pressure cylinder was 23in. in diameter and was double acting. The stroke of all three cylinders was 15in. Steam was cut off at half stroke in the high pressure cylinders and at quarter stroke in the low. The boiler supplied steam at a pressure of from 350 to 500 lb. per square inch. It consisted of "a number of sections composed of layers of horizontal tubes connected together by short tubes of small diameter, the fire-box being formed with simply a casing of these tubes." The boiler used nothing but distilled fresh water and the condenser was so constructed that the boiler water could not mix with the salt condensing water. The complete boiler had been tested to a pressure of 2500 lb. per square inch, and each tube separately to 4000 lb. The "Anthracite" was originally built for Mr. Robert M'Calmont with a view to testing the Perkins system on the Atlantic voyage. Serious illness prevented him from carrying out his intention and the ship was acquired by the Perkins' Engine Company, which forthwith arranged to send her to New York in accordance with the original plan. The "Anthracite" was one of several boats of various sizes which by the date named above had been fitted with Perkins' engines and boilers. All earlier sources of trouble and annoyance had, we reported now been, apparently, overcome. In particular the gauge glasses were now made of talc and the piston rings of an 84–16 copper-tin mixture. Perkins claimed that his boilers, even should a tube give way, were immune from dangerous explosion and that his system gave a great economy of coal, only about 1·2 to 1·5 lb. being consumed per horsepower hour. On May 26th, 1880, the "Anthracite" ran a satisfactory trial trip in the Thames estuary. We reported that a steam pressure of 360 lb. was maintained with the greatest ease, the damper being almost closed during the whole run. All the distinguished company on board remarked upon the ease with which the steam pressure could be increased by 30 to 40 lb. at will and upon the coolness of the engine-room and stoke-hole.

Mastering Momentum in Transport*

By L. K. SILLCOX†

No. III

(*Continued from page 481, May 24th*)

Thermal Crack Prevention.—Due to the prevalence of thermal cracks in wrought steel wheels which accompanied the widespread increase in passenger train speeds, rigorous research activity was instituted in the field. Reduced unit wheel loading would be effective in correcting the difficulty by reducing the brake shoe pressure required to provide a specified stopping distance. Lighter static loads would also retard crack propagation since cracks grow most readily under shock. However, since minimum equipment weight is necessary in the most economical operation of high-speed services, reduction in wheel loads has proven to be a distinctly unpopular method of overcoming wheel defect difficulties. The objective was sought in crack-resistant properties in the wheels themselves. None of the highly developed alloys proved to be very effective in this direction. There were wheel types offered which produced better mileage records than others without the development of condemning thermal cracks. Forging practices were varied, heat treatment applied, and still no truly satisfactory wheel was reported until low carbon wheels, heat treated to develop rim toughness and tread hardness, were offered. The heat treated, low carbon wheel does not thermal crack readily. Its tread metal does flow with relative freedom, particularly if highly heated by brake shoe friction. Deliverance from the thermal crack, probably the most malicious of wheel defects and one which can propagate rapidly under certain conditions to produce complete collapse of the wheel, has encouraged railways operating heavily braked, high-speed equipment to adopt the low (approximately 0·5 per cent.) carbon wheel in these services.

Shelling of Wheel Treads.—A low carbon wheel, resistant to thermal cracks, is particularly subject to enforced removal for the companion defect, shelling—companion in the sense that the two types of failure are functions of structural breakdown, not that they arise from like cause. In the first stages of shelling, with an interior fault extending to the tread, a surface crack may appear, distinguishable from the fissure of the thermal crack which always lies transversely of the tread, in that it is irregular in pattern and path. It often grows to enclose an area of tread from which the surface metal falls out to a depth of $\frac{1}{16}$in. to $\frac{5}{16}$in. Its size varies. The shelling out of tread metal is commonly associated with the use of low carbon wheels of inherently low Brinell and the application of very high unit wheel loads. Lack of homogeneity in metal structure and the existence of definite planes of weakness in shear assist the quick development of shelling tendencies. The cause of the defect is identified as the overloading of the wheel tread metal beyond its elastic limit in the restricted area of contact between wheel and rail. The low carbon wheel is particularly susceptible since it does not possess the high strength characteristics of the harder structure—yet tougher and more ductile, it resists the formation and growth of thermal cracks. Since shelling of wheel treads is the result of crushing action and develops into initial surface cracks through the shearing of metal along fixed planes, the influence of non-homogeneity is obvious. Slip lines are identified with the local flow of metal, one stratum moving with respect to the next. A cone of stress results from concentrated pressure and planes of weakness are sought out as the wheel rotates. Plastic flow will be complete and the material will adjust itself by deformation if sufficiently ductile. A hard and brittle material, while, in the general case, being capable of receiving higher stress before failure, will finally give way by rupture if repetitively loaded beyond its capacity. University of Illinois Engineering Experiment Station Bulletin No. 212 reviews various methods which have been proposed for calculating stress induced by bearing of one surface upon another in restricted contact area. The researches of Hertz, Rankine, Saint Venant, Coulomb, and Mohr are commented upon and their limitations defined. A process is then developed for the mathematical derivation of maximum shearing stress, at whatever distance beneath the surface it may be developed, arising from the combination of stress active in different planes. Considering a car wheel rolling upon a railway rail, the relationship represents two cylinders resting, one upon the other, with axes at 90 deg. The rail head, having an approximate circular contour in a transverse plane, supports the wheel, itself a cylinder. Calculating the maximum shearing stress arising from contact of wheels of 30in. to 80in. diameter under loads of 20,000 lb.

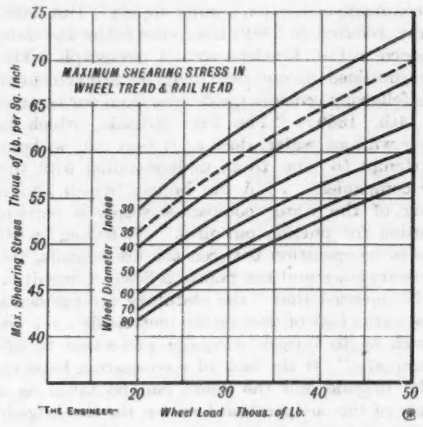


FIG. 1

to 50,000 lb., and assuming the rail head radius to be 14in., values are produced as shown in Fig. 1.

Explanation of Process.—Contact of two crossed cylinders, whose axes are at right angles to each other and which are under no pressure, occurs at a point. As pressure is applied, the curve of compression describes an ellipse, the dimensions of which increase in proportion to the increasing applied force. Consider two systems of co-ordinates, *xyz*, and XYZ, as applicable to two bodies, 1 and 2, in contact, the *z* axis to be normal to the cylinders through the centre of the contact area while the *x*X and *y*Y axes coincide. Also consider that the point of contact occupies the (0, 0, 0) origin of the two co-ordinate systems. Upon the application of pressure, the centre of the area of contact is displaced from the $z=0$ plane by an amount z, which is the function of xy, and an

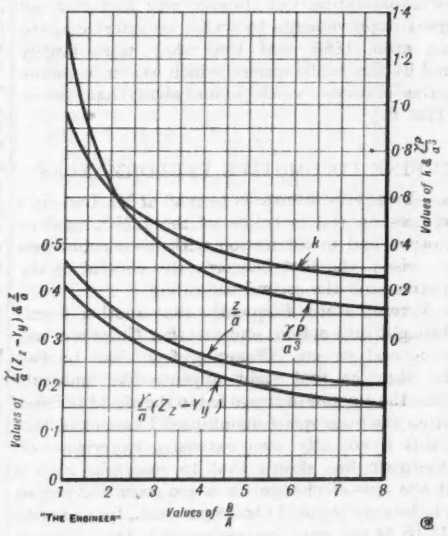


FIG. 2

amount Z, a function of XY, and the distance the bodies approach each other is defined as $z+Z$. The chart, Fig. 2, is a reproduction of one appearing in Bulletin No. 212 upon which are plotted curves representing various terms involved in the arithmetical solution of the type of problem under discussion. The mathematical theory supporting their use involves an elaboration of the Hertz theory.

Example.—As illustrative of the application of this method, consider a problem of the following conditions in which it is required to determine the maximum shearing stress imposed by a given load, the distance from the contact area to point of maximum shear, and the area of contact.

Conditions :—

Crossed cylinders (wheel on rail)

R_1 = radius of curvature of wheel = 18in.

R_2 = radius of curvature of rail = 14in.

P = total pressure between wheel and rail = 25,000 lb.

σ = Poisson's ratio (the ratio of lateral to longitudinal unit deformation upon the application of tensile or compressive stress)—taken as 0·25

E = modulus of elasticity = 30,000,000 lb. per square inch

Let A = one-half the reciprocal of the radius of curvature of the wheel

B = one-half the reciprocal of the radius of curvature of the rail

b = semi-minor axis of the ellipse of contact

a = semi-major axis of the ellipse of contact

k = ratio of b to a

γ = a function of the elastic properties of the two bodies and their shapes at point of contact

z = depth from contact surface on z axis to point of maximum shearing stress

$Z_z - Y_y$ = components of the stress across planes perpendicular to the x, y, and z, directions through the point

$Z_z - Y_y$ = Maximum difference of stress components

$$\frac{B}{A}=\frac{1}{2\times14}\times\frac{2\times18}{1}=1{\cdot}285$$

From the chart, Fig. 2, the following values are read for the case, $\frac{B}{A}=1{\cdot}285$

$k=0{\cdot}838$

$\frac{\gamma P}{a^3}=1{\cdot}01$

$\frac{z}{a}=0{\cdot}428$

$\frac{\gamma}{a}(Z_z-Y_y)=0{\cdot}375$

When $\sigma_1=\sigma_2=\sigma$ and $E_1=E_2=E$, γ is defined as

$$\gamma=\frac{2(1-\sigma^2)}{E(A+B)}=\frac{2(1-0{\cdot}0625)}{3\times10^7\times0{\cdot}0635}=9{\cdot}84\times10^{-7}$$

Since $\frac{\gamma P}{a^3}=1{\cdot}01$, $a=\sqrt[3]{\frac{9{\cdot}84\times25{,}000}{10^7\times1{\cdot}01}}=0{\cdot}29$in.

$b=ka=0{\cdot}838\times0{\cdot}29=0{\cdot}243$in.

Area of contact $=\pi ab=3{\cdot}1416\times0{\cdot}29\times0{\cdot}243=0{\cdot}2215$ square inch

$$(Z_z-Y_y)=0{\cdot}375\frac{a}{\gamma}=\frac{0{\cdot}375\times10^7\times0{\cdot}29}{9{\cdot}84}=110{,}600$$ lb./square inch.

Many Strength of Materials * texts contain mathematical proof that, when a point within a body is subjected to stress components acting at right angles to each other, the

$$\text{Maximum shearing stress}=\frac{Z_z-Y_y}{2}=\frac{110{,}600}{2}=55{,}300$$ lb./square inch.

Depth to point of maximum shear, $z=0{\cdot}428\,a$
$=0{\cdot}428\times0{\cdot}29$
$=0{\cdot}124$in.

The same Bulletin furnishes the following empirical equation which may be used to check values of Z_z-Y_y :—

$$Z_z-Y_y=\frac{23{,}500}{(R_1/R_2)\,0{\cdot}271}\,\frac{\sqrt[3]{P}}{\sqrt[3]{R^2_2}}$$

In its application to the above example :—

$$Z_z-Y_y=\frac{23{,}500}{(1{\cdot}285)\,0{\cdot}271}\times\frac{\sqrt[3]{25{,}000}}{\sqrt[3]{(14)^2}}=110{,}200$$ lb./square inch.

And, maximum shearing stress $=\frac{Z_z-Y_y}{2}=\frac{110{,}200}{2}$
$=55{,}100$ lb./square inch.

Service Interpretation.—A 36in. wheel, supporting 25,000 lb. static load, is a common specification for traction wheels of diesel-electric trains. Tangential shear components in propulsion add to the stress in tread metal. Dynamic effects in motion are generally estimated at 100 per cent. of the static weight. There is indicated resultant

* A Discussion of Modern Transport Trends and their Influence upon the Equipment of American Railways, Massachusetts Institute of Technology, 1940.

† First Vice-President, The New York Air Brake Company.

* For example: Fred B. Seely, "Resistance of Materials." Wiley & Sons, 1925, page 53.

shearing stress of approximately 110,000 lb. per square inch before adding the tangential load which is impressed during both acceleration and retardation cycles. With 25 per cent. wheel-rail adhesion, this may equal 6000 lb., a relatively unimportant component but one which is superimposed upon an already highly stressed structure. Many wheel difficulties would be promptly dismissed if it were found practicable to so lighten equipment, or increase the number of carrying wheels with respect to load, that the materials utilised would no longer be stressed to the working limit of the best physical properties which it is possible to introduce into them. However, as long as reasonably satisfactory results can be secured through the use of available materials, and the demand for high speed endures, requiring the elimination of every unnecessary pound of dead weight, the appeal for more liberal design to lighten the duties imposed upon concentrated metal masses will attract little sympathy from responsible users of the equipment. Wheel removals for slid flat spots are much more common than removals for thermal cracks and shelling, and so the expense for the latter two defects are submerged in the much larger item for total wheel maintenance. Hollow worn treads will be eliminated as the cause of consecutive wheel and axle removals with low intervening mileages as brake shoes are removed from the treads, based upon the limited observations which a brief trial period permits. This, in itself, will be a factor, but scarcely a decisive one, in influencing railways to consider one or another of the axle brake types. The wheel situation is improving with advancing knowledge, but improvement in one direction has been obtained at the expense of performance and economy as influenced by other aspects. Of particular significance is the success which has been witnessed in the development of a wheel which is highly resistant to the development of the most dreaded of defects, the thermal crack.

Wheel Tread Taper.—Riding comfort is not generally associated with the design of a steel wheel and the use of resilient construction in trunk line railway services appears quite remote in view of railway practice in the assignment of wheel loads. The steel wheel, although devoid of any measurable cushioning properties of vertical or horizontal loads, has been shown to have distinct effect upon the lateral stability of car bodies as influenced by tread contours. The standard tread for passenger train car steel wheels consists of a 1 : 20 straight taper, the result of controversy extending over a period of many years. Railway mechanical officers have never been unanimous in their acceptance of this or any other form proposed for standardisation. Wheel treads are tapered and rails are canted to fit the taper, but there has been no convincing explanation for either. Some originally held that the taper was furnished to alleviate wheel slippage on curves. The manner in which a car truck runs into a curve, and the different paths followed by leading and trailing wheels of the same truck in the general case, would destroy any advantage which might be claimed, fitting the taper ideally to the degree of curve to be passed in any case.

Hunting.—Under ideal conditions, requiring identical wheel diameters at the axle ends, tangent track, an axle which is exactly normal to the track, and no outside disturbing forces, a wheel and axle assembly with tapered wheel treads will run centrally of the track upon equal wheel diameters. Such a condition very seldom can occur. Instead, if the wheel flange presses the left-hand rail, the left-hand wheel is turning upon its largest diameter. The opposite wheel rotates upon a smaller diameter, the exact relationship depending upon tread taper, track gauge, and rail surface. The axle assembly now tends to swing to the right until the right-hand wheels runs upon a diameter larger than that of the left. Direction again tends to change and so on, the solidly mounted wheels, if undisturbed by outside forces, following a sinusoidal path, the wheel flanges never contacting the rails if the process is deliberately carried on with no high inertia values built up in the wheels in any direction. Tapered wheels in service are constantly attempting to oscillate laterally in this manner, but they are always subject to some external influence which invariably acts as a restraint. For instance, a wheel and axle assembly—an integral portion of the car truck—can assume no form of motion independently of its journal boxes, the truck frame, and thus the other pair or pairs of wheels, each pair endeavouring to follow its own sinusoidal path. Truck wheel base is a factor in establishing this interference and defining the period and path of oscillation of the truck as a whole.

Hunting Restraint.—The service, or train riding quality, significance of these tendencies is important, particularly in its relation to recent railway experiences and methods of correcting difficulties which have arisen in controlling the motion of passenger cars. Bearing in mind the determined attempt of each axle to weave back and forth, right and left, as it advances along the track, just what forces act to restrain it or to amplify its effect? First, there is the sometimes conflicting action of other wheel and axle assemblies in the same truck. A single axle of a six-wheel truck has less opportunity to bring its mate axles into synchronism than if it were one of but two in a four-wheel truck design. In the latter case, if the trailing axle follows the forward with a lag of a few degrees angular motion the whole can move as a unit with very little interference. If the wheel on one axle end is larger than its mate by any small amount deflection of the truck will not be uniformly disposed on either side of the centre line of track and resonance will be obstructed. Friction in the truck centre plate or side bearing contact will interfere with the freely swinging tendencies of the four-wheel truck. Since the truck cannot be displaced laterally without corresponding motion of the car end, the nature of car couplings affects the freedom of lateral movement. Then, too, wheels which are installed with treads formed to a definite taper do not long retain the design dimensions. Wear modifies the taper and, thus, the lateral oscillation tendencies.

(To be continued)

Skin Troubles and Machine Tools

By ALEXANDER DUCKHAM, F.C.S., F. Inst. Pet.

NEARLY forty years ago, when, as a young chemist, the writer started in business, his godfather, Sir Alfred Yarrow, suggested to Messrs. Vickers that they should allow him to investigate the skin trouble which their machinists were experiencing on hands, arms and faces.

They were using olive oil as the coolant on the machines and, therefore, it appeared that the trouble could not have been due to irritation and so one had to look elsewhere for its cause.

As the first step, an examination was made for bacteria, and those identified were such as to lead at once to the conclusion that they were getting into the oil from the hands of men suffering from venereal troubles, and thence were conveyed by the oil into scratches on the hands and arms of their fellow workpeople. Doctors were called in, men were examined, and those who had the disease were put off for treatment. All having any trace of the trouble were removed from machines. All used oil was discarded, and a fresh supply put in. The trouble then disappeared for the time being. This, as far as is known, was the first case of such an investigation having been made. We rested satisfied with the theory of bacterial origin, but as the years passed we gathered more and more information, and it became obvious that although such contamination was a factor it was not the main one. Only recently did we appreciate the fact that there was not extant any treatise dealing adequately and simply with these skin troubles in works. Consequently, for humanitarian reasons and for the sake of national efficiency, the writer is setting forth such information as he has collected.

The health and general well-being of those engaged in industry calls for special attention in these days of stress. At the time of writing, the *Daily Telegraph* reports that "the result of the tremendous strain placed on German workers is a great increase in accidents and occupational diseases." The last 25 years have proved beyond doubt that, from the standpoint of efficiency alone, it is unwise to leave the care of his health to the individual worker, and that well-planned expenditure by the management on measures for the prevention of disease is a sound investment.

Dermatitis.—Among the chronic disorders affecting machine shop workers dermatitis is widespread. The term is a broad one covering any variety of skin inflammation produced by irritation—mechanical, chemical or bacteriological. Dermatitis occurs not only among machine tool operators, but among bakers, jam makers, chemical workers, electro-platers and in many other industries. Our first concern here is oil dermatitis. In general, the symptoms commence with a rash and the appearance of small swellings around the sweat glands. The area affected becomes inflamed and painful. Frequently suppuration sets in so that the case becomes infectious through the medium of towels, swabs, tools or anything handled. In other cases, there is little or no suppuration, but constant itching and smarting, whilst the swellings become indurated.

The Skin.—The human skin has many functions besides that of a protective covering. One of the more obvious is the discharge of perspiration, which performs the double duty of cleansing the skin and cooling the body when overheated. The skin also discharges waste products (not only when visibly perspiring), and a natural grease which renders it supple and partially waterproof. It also acts as a laboratory in which, by the action of sunlight, substances indispensable to health are manufactured. The natural grease of the skin includes substances of the sterol group, such as ergosterol, which are converted by ultra-violet light into vitamin D, and either locally, or on absorption, play an important part in the defence of the body against disease.

Causes of Oil Dermatitis.—Microscopic examination of the hands and arms of machine tool operators shows that, even after the skin has apparently been washed quite clean, every pore in certain areas is clogged with a small black plug of oil. The blackness is caused by dirt, consisting partly of very fine, sharp metal dust. This plug sets up irritation directly and also indirectly, by choking the natural discharge of sweat. Further, the skin is deprived of its natural grease by daily contact with excess of lubricating oil, which renders it oil-sodden and less able to withstand the mechanical injuries from needle-like particles of swarf to which it is constantly exposed.

PREVENTIVE MEASURES

Personal Cleanliness.—It is important that efficient washing arrangements be provided. For machine shop workers, it should be sufficient to cleanse the hands, arms and face, for although dermatitis often appears on the thighs as a result of oil having penetrated the clothing, it is easier to provide oilproof aprons than to arrange for daily baths. The question of cleanliness should be studied also from the workers' point of view. When the hooter blows, the machinist, like the rest of us, is anxious to go home, and does not want to hang about waiting his turn to wash.

On the other hand, there are few of us who would grudge a little delay in getting to our machines or our desk, if it meant a few minutes of the employers' time, when we arrive in the morning. In any case, ordinary washing which renders a man presentable in appearance is quite insufficient as a safeguard against oil dermatitis.

Nevertheless, as the causes and means of avoiding dermatitis become better known, those individuals who are especially susceptible and have learned to dread the disease, will wish to spend time on getting clean. A good supply of hot water should be available, and it is well also to allow those who will use it properly a ration of spirit soap, a non-gritty grease-removing product, which greatly assists in quick removal of oil from the skin.

Protection of the Skin.—This is one of the simplest and most effective measures. A suitable oil-resisting ointment is rubbed well into the skin before work, preferably immediately after opening the pores by a wash in hot water. Whilst it blocks the pores for the time being, it does so with a non-irritant material which, being water-soluble, does not hinder the discharge of sweat. The lubricating oil is thereby prevented from penetrating and a simple wash at the end of the day is sufficient to restore the skin to a hygienic condition.

Replacement of Natural Skin Grease lost through Contact with Lubricating Oil.—Lanolin is the skin grease of sheep. It resembles human skin grease and can, with advantage, be applied as an ointment. This is especially necessary when the skin has been degreased with petrol, paraffin or spirit soap.

General Hygiene.—Like other diseases, dermatitis attacks, particularly, those in a low state of general health. Many large works maintain resident medical officers and one at least has installed artificial sunlight lamps for the use of employees. Diet plays a big part, and if fresh foods are not taken in sufficient quantity the vitamin supply should be supplemented. This is generally done under medical direction by taking vitamin concentrates internally, but it has been lately suggested that ointments containing vitamins as well as sterols would be of value in combating dermatitis. Certain recent experimental evidence gives support to the theory underlying this suggestion, namely, that a contributory cause of oil dermatitis is local vitamin starvation, which can be remedied by absorption of vitamins applied externally.

Cleanliness of Machines and Coolants.—The old idea that dermatitis arose from an infected condition of the coolant has long been proved erroneous. Nevertheless, if workers with open sores are not immediately laid off, the resulting contamination of the oil or suds, and all else they touch, can be a danger to their fellows. Medical supervision cannot entirely forestall this risk, and it is wise to ensure that the coolants remain bacteriologically harmless. Sterilisation by heat is effective for lubricants known to be infected, but damages the oil if constantly applied. A trace of antiseptic in the coolant is sufficient to ensure that no harmful organisms can long remain active, and is usually added by the manufacturers. It should be borne in mind, however, that this antiseptic is liable to deteriorate in germicidal efficiency during use. Some works make a practice of adding fresh antiseptic at intervals, but care should be taken that an excess does not accumulate in the oil or more harm than good may be done owing to the irritant action of high concentrations. The gradual disappearance of central circu-

lating systems for suds and oil has greatly simplified the infection problem, since a single machine, which has become contaminated, can be disinfected, oil and all, without much trouble.

Selection of Workers..—Certain individuals have a marked predisposition towards dermatitis and should, as far as possible, be allotted to work which will not cause any skin irritation. In this connection, medical examination of applicants for employment is of value. In one works, where many thousands are employed and transfer to non-irritant work is a simple matter, the medical officer claims to have stamped out dermatitis by this means alone.

Dermatitis Among Workers Using Aqueous Solutions.—Aqueous oil emulsions, or suds, as used for coolant purposes on machine tools, can give rise to dermatitis in a manner similar to straight cutting oils. Whilst the emulsion has less clogging effect than neat oil, the constant wetting softens the skin and weakens its resistance to injury by particles of swarf. In this case a water-resisting dressing is preferable for protective purposes, and a lanolin base ointment is suitable. The same applies where the irritation is due to chemicals, caustic dips, or chromium-plating solutions.

To sum up, oil dermatitis can, with almost complete certainty, be eradicated if supplies of preventive agents comprising (*a*) oil and water-resisting protective skin dressings ; (*b*) an effective hand cleanser, are available, and their use encouraged. Such agents are now easily obtainable.

Improved Efficiency of Dredger Pumps

Difficulties which arose in the dredging of the mouth of the Gironde river, on account of the insufficient capacity of existing types of dredger pumps for carrying off fluid mixtures of sand or mud and

FIG. 1—IMPELLER WHEEL

water, have led to studies resulting in the construction of an improved type of pump. These pumps, the result of experimental work carried out by the engineers of the Service des Ponts and Chaussées

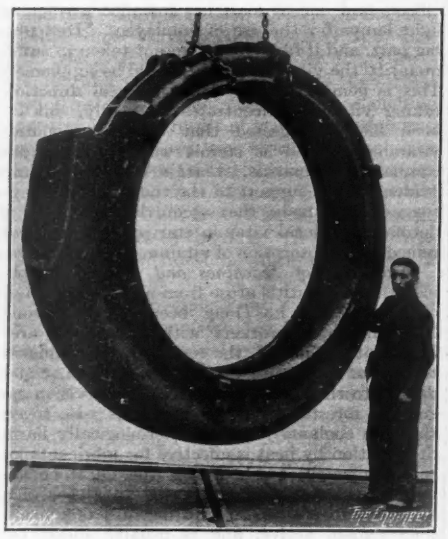


FIG. 2—VOLUTE CASTING

and of the firm of Beaudrey-Bergeron, permitted, without increase in the consumption of motive power used, an increase in the capacity of dredgers from 350 cubic metres pumped a distance of 900 metres, to 700 cubic metres pumped a distance of 2000 metres.

To obtain this result it was necessary to produce a pump with exceptional suction abilities, and to provide means for preventing the stoppage of the outlet pipe that occurs whenever the quality of solid in suspension exceeds the critical capacity of a pump at a given regime. Moreover, it was desirable to provide a pump which was no more complicated than the usual types. At the time when experiments were begun it was believed that the best existing pumps had an efficiency of 60 per cent. to 65 per cent., whereas the new pump has 75 per cent. efficiency.

The design of the pump, which was worked out as the result of successive tests on various models, is quite simple. The main parts of the pump are the

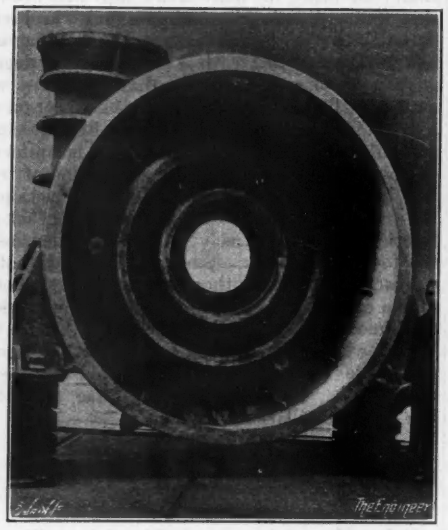


FIG. 3—PUMP CASING

impeller and a volute, contained inside a case and each held in place independently by plates bolted in position on the casing. The impeller is of the single-entry shrouded type, Fig. 1. The eye side of the impeller, which fits into the casing, is provided with a series of " sealing rings."

The impeller is made as a single casting in chrome steel. This material can be machined without too much difficulty and stands up well to the erosion that is bound to occur when pumping solid matter in suspension.

The volute, which forms a separate casting fitted inside the pump casing, Fig. 2, requires practically no machining. As it has to stand up to heavy erosion,

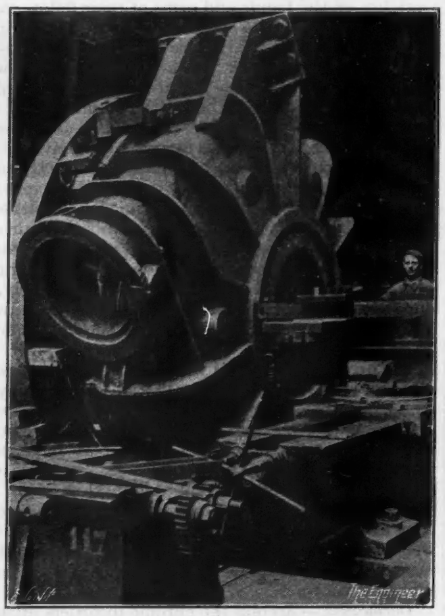


FIG. 4—MACHINING CASING

it is made as a single casting in manganese steel and is bolted in place inside the casing without any other finishing than the edges in contact with the diffuser. To render possible the insertion of these parts, the casing, Figs. 3 and 4, is of a rough dome shape. It is an ordinary steel casting, ribbed inside and out for strength, and provided with the necessary holes for bolting the volute into position. Once the volute has been fixed inside, an annular cover plate, Fig. 5, can be bolted on to the bottom of the casing to hold it in position. This plate is also a heavily ribbed steel casting in ordinary steel. A final cover, Fig. 6, is bolted in position in the annular one, to hold in the impeller. This cover has a number of openings provided with flanges. Water pipes can be bolted on for the admission and discharge of clean water which circulates around the outside of the volute and the flanges of the diffuser, and permits any solid particles which may work their way out through the clearance between these parts to be carried off. In this manner any unnecessary erosion of the diffuser flanges owing to grinding of these particles between the flanges and the casing is eliminated.

As has been mentioned, the pumps were installed in the place of existing pumps which had proved in-

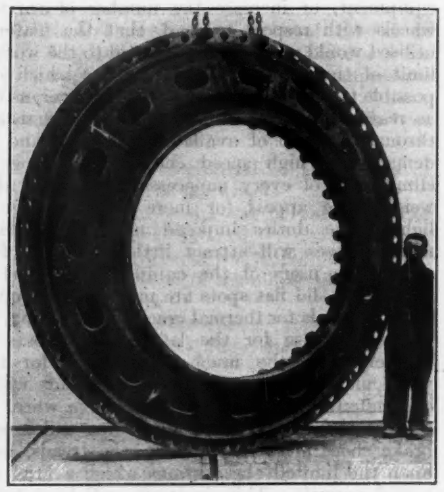


FIG. 5—COVER PLATE

sufficient in the dredgers used for clearing the channels in the mouth of the Gironde river. The power available for their operation on these dredgers was about 1000 B.H.P., which proved sufficient to operate them at double the capacity of the old ones. In the calculation of dimensions, one interesting point is that the pumps were not designed to take the exceptionally large lumps which many ordinary pumps can take up without clogging. This permitted a

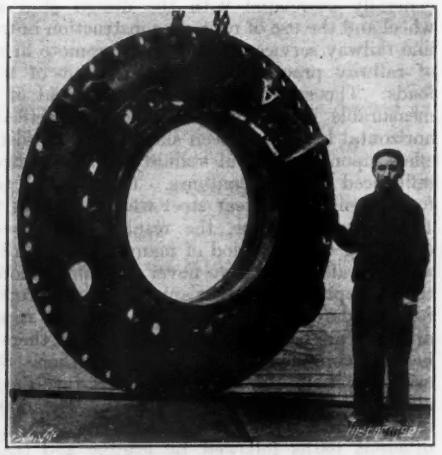


FIG. 6—FINAL COVER PLATE

considerable improvement in the design and efficiency, as well as permitting finer calculations of play. On the intake side of the pumps, therefore, it was necessary to provide a grill with openings slightly smaller than the maximum size passage offered, so as to avoid clogging.

A New Form of Steel Building

We recently had an opportunity of inspecting the first of a new type of steel building, designed by Mr. G. Bacher, which has been constructed by E. Pollard and Co., Ltd., of St. John Street, London, E.C.1. In the new design all the component parts of a building interlock and are assembled rapidly and easily by unskilled labour without the use of special tools, bolts, screws, welding, or any other means for connecting the parts together.

The walls are built up of 18-gauge bright cold rolled steel sheets fabricated into the sections shown in the drawing. These sheets are assembled into what are virtually 8ft. high steel boxes 18in. wide, each being interlocked with those on either side. Referring to the drawings it will be seen that one box is formed of two sheets AA, the shaped faces on either side of which dovetail into the formed sides of the sheets BB. The pairs of sheets AA, BB are held 4½in. apart by U-shaped spacing channels along the bottom and the top of the wall and are locked together on these channels by a spring clamp or strap C which extends practically their full length. In these clamps two holes are punched near the top in order to facilitate their withdrawal.

The spring effect of the curved sides of the sheets BB in the angular sides of the edges of the sheets AA is so designed as to draw the " boxes " together under the influence of the clamps, and form joints capable of resisting the ingress of rain or wind.

The " boxes " so formed are filled with insulating material such as slag wool, asbestos, shavings, sawdust, straw, &c., which in addition to preventing the transmission of heat also acts as sound insulation in the walls.

Around the foot of the inside walls a skirting is formed by a length of channel section steel sheet D, which projects under the inner sheet of the walls and laps over the spacing channels. At the base of the outer walls an apron E is held in a similar way, its outer section being, however, turned downwards to divert water away from the footings. Sheets of similar section to those used for the skirting are used to form a ceiling channel or picture rail round the tops of the inner walls. In the case of parting walls the skirting and ceiling channels are formed on the edges of a large U-shaped section which extends over the complete thickness of the wall. The guttering round the roof edges is supported by steel sheets formed to project under the roof truss shoe supports and round part of the wall spacing channel.

The roof and ceiling are built up of similarly formed sheets to those used on the walls, held in position by specially fabricated truss members F. Tie bars for the roof are coupled to plates welded in pairs on either side of the trusses. Any water which might leak through the roof joints drains into the gulleys which are formed by the locking angle at the edges of the sheets, the natural slope of the roof conveying any such water down into the gulley round the sides of the roof. Shoes welded to the truss members and held in position by a retaining sheet distribute the weight of the roof around the outside walls. The ridge of the roof is a separate member which is held in position by horizontal tie bars. Where doors are fitted, a narrow box-shaped section, as shown at G, is fastened on to the wall section and held in the usual way with a clamp. On the section supporting the door a pair of loose pin hinges are welded into recesses, and the opposite door section has rubber buffers let into its recesses to reduce noise and prevent damage to the door.

Standard metal windows are easily fitted where needed by the inclusion of a special head and short wall sections below. The cill comprises a formed plate and the window frames are made waterproof by the use of a mastic packing. As stated above, the parting walls are of similar design to the outer walls, and are held in position by fillets screwed into the adjoining walls. Where fireplaces are installed extra-wide sheet sections are used and the flue pipes pass up the centre of these sections. The space between the flue and adjoining wall sheets is filled with a non-inflammable and heat resisting material such as sand.

From the above description it will be seen that bungalows, huts, or houses of this type can be easily and rapidly erected or dismantled by comparatively unskilled labour. Their design facilitates comprehensive and extensive alteration to the interior arrangement of the rooms and also allows extensions to be made as and when required without disturbing the original structure.

Before the steel plates are dispatched from the factory they are dipped in a bath of Chromate paint which in addition to its rust preventing properties permits a considerable amount of handling without damage to the protective surface. Although the structure we inspected was in the form of a bungalow, we were shown designs of two and three-storey houses built on the same principle.

Canadian Engineering News

(By our Canadian Correspondent)

Steel Plant Extensions

The Steel Company of Canada, Ltd., Hamilton, Ontario, decided, immediately following the outbreak of war, to extend its productive capacity in several respects in order to place it in a position to meet promptly any possible extraordinary demand for steel, for domestic as well as war needs. The major items involved are as follows: In the open hearth department, the erection of an additional 150-ton open hearth furnace, which will increase the ingot capacity by approximately 100,000 gross tons per year. In addition to the furnace proper, the work undertaken includes extensions to auxiliary departments, such as scrap yards, mould preparation yard, and hot metal mixer. At the bloom and billet mills two additional large soaking pits of the most modern type available, embodying fully-automatic regulation and heating are being installed to heat the increased production from the new open hearth furnace, preparatory to the blooming mill operations. At the company's sheet mills, additional warehouse area is being provided to facilitate prompt handling and shipping of the sudden increase in volume of domestic business which has arisen on account of war conditions. The total cost of these extensions at the Hamilton works will be approximately 1,250,000 dols. Quite extensive improvements are being made as well at the various wire mills of the company to increase production, at a further cost of approximately 200,000 dols., for work authorised since the outbreak of the war.

Treatment of Wooden Poles

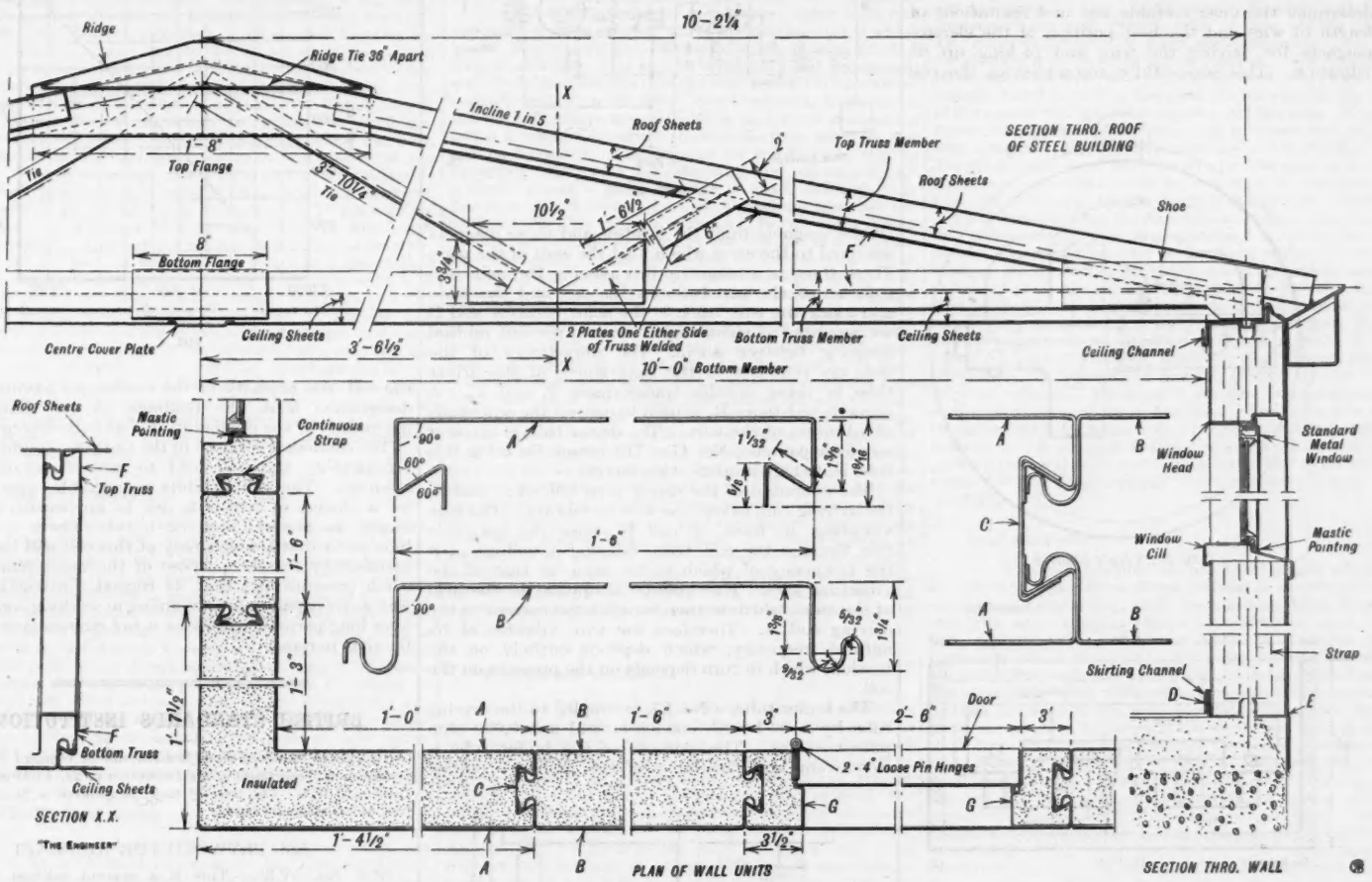
Experiments carried out at the Forest Products Laboratories of the Canadian Department of Mines and Resources have resulted in the development of a preservative treatment for the butts of poles in telephone and power lines erected in remote districts. Longitudinal holes are bored in the butts of the poles near the circumference and alternate holes are filled with copper sulphate and sodium arsenite. The poles must be treated and set as soon after cutting as possible. The treatment is not effective in dry poles, and the bark should be left on the butt up to the ground line. Evaporation of the moisture from the tops of the poles draws the preservatives up to the sapwood from the holes in the butt. The two chemicals used are both soluble in water, and as they are drawn up the pole they meet. A chemical reaction occurs which forms a new substance—cupric arsenite—which is insoluble in water and an effective preservative against the organisms which attack the wood. This reaction occurs at the ground line where the decay is greatest. The treatment, according to the laboratory engineers, will provide protection from decay for several years. Test poles which have been in service for six years are in good condition, while adjacent untreated poles set in the ground at the same time are decayed at the ground line.

New Control System

A new system for automatically regulating the power input to electrically heated equipments, such as furnaces, boilers, superheaters, and air heaters, has been announced by the Canadian General Electric Company, Ltd. Called the Reactrol system, this new means of control regulates power input by varying the voltage impressed on the heating resistors in accordance with temperature or pressure requirements. It is particularly suitable for continuous processes and in the treatment of materials that might be affected by slight changes in temperature. In its simplest form, the Reactrol system consists of a control panel, a temperature or pressure control instrument, and a saturable-core reactor. In operation, the pressure or temperature control instrument (which contains a special potentiometer) feeds low-voltage current into an amplifying tube on the control panel. This tube, in turn, regulates the flow of direct current to the saturable-core reactor which, acting like a valve, regulates the voltage applied and thus the amount of power going to the electric heating equipment.

Kootenay River Developments

Considerable progress has been made on hydro-electric development work on the property of the West Kootenay Power and Light Company, Ltd., in British Columbia. The company recently completed the removal of materials from the bed and sides of Kootenay river at Grohman Narrows near Nelson. This work was carried out in compliance with an order of the International Joint Commission permitting storage of water in Kootenay Lake. During the past year a total of 334,585 cubic yards of gravel and boulders were removed, and 17,927 cubic yards of solid rock. This enlargement will materially increase the flood capacity and generally improve the situation on the Kootenay river. Further to utilise the storage waters thus made available, the company, during the past year, carried forward the extension of its hydro-electric station at Upper Bonnington. This scheme involves the installation of two new turbines of 25,000 H.P. each with two 20,500 kVA generators and other necessary equipment.



DETAILS OF NEW FORM OF STEEL BUILDING

The Measurement of Earth Pressure*

By I. F. MORRISON† and W. E. CORNISH‡

Although much has been written on the theory of earth pressures on retaining walls and below foundations, the present need is of measurements to confirm the theory and to establish such basic principles as may lead to a practical method for the computation of such earth pressures. A number of earth pressure measuring cells have been developed, but they fall short, somewhat, of what is hoped will be the ultimate development of such apparatus. It is the purpose of this article to describe another attempt to develop a suitable earth pressure cell.

The requirement of a suitable earth pressure cell is that it shall be capable of measuring with requisite accuracy the active earth pressure that comes upon it. Some pressure cells already in use do not meet this requirement. In addition, the cell must be "hard," i.e., it must measure the pressure with as little movement of the surface, to which the external pressure is applied, as possible. Moreover, the measurements must be recorded on instruments at some distance from the cell itself and, therefore, by indirect observation. In addition, it must be reliable over a considerable time interval.

To meet these requirements, it was decided to use the vibrating wire method, and to this end preliminary studies were made of the electrical arrangement to determine the most suitable size and limitations of length of wire and the best position of the electromagnets for driving the wire and picking up its vibration. This successfully accomplished, the cell

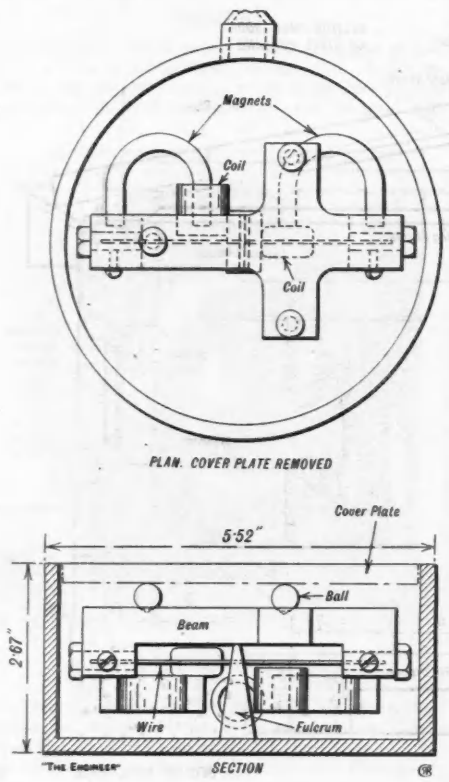


FIG. 1

was designed with due regard to the hardness requirement and its practical and rugged construction. Its range was planned to extend to an equivalent soil pressure of 7500 lb. per square foot, which required a load of slightly over 1000 lb. on the cell.

The working part of the cell consists of a stiff, T-shaped beam which rests on a properly located knife-edge fulcrum. At the free ends of the beam, short arms project downwards. The wire is securely held at its ends by these arms. It passes, below the beam, through a slot in the fulcrum. The T-shape was adopted in order to secure a three-point support for the cover plate through which the soil pressure is transmitted to the beam and thereby to eliminate the effect of flexural strain of the cover plate on the readings given by the electrical equipment.

In addition, since any cell for such purpose must be capable of continued operation over a long period, it was decided to lessen the possibility of creep in the wire tension by working from a higher tension to a lower, and for that purpose the single fulcrum was adopted. Besides, the single fulcrum fairly well eliminates the effect of distortion of the base of the cell. Fig. 1 shows the arrangement as described above and also the arrangement of the magnets in the vicinity of the tight wire.

The T-beam was cut from a steel plate ½in. thick and, as the point of application of one-third of the total pressure on the cover plate is but 1½in. from the fulcrum, the beam is quite stiff. For full load the computed movement of the cover plate amounted to about 0·001in., so that the cell may be considered fairly "hard."

From previous experimental work, the most suitable size of wire was found to be 0·020in. diameter and a piece of steel piano wire, as near this size as practical, was used. The clear length of the wire is about 2¾in. and the ends are securely fastened into steel sockets which pass through the arms at the ends of the beam. The sockets are threaded and provided with nuts for tightening the wire to its initial tension. Also set screws are provided to keep the sockets from turning.

The vibrating wire method consists of causing the wire to vibrate and measuring the frequency of vibration of the wire. As load is applied, the tension in the wire decreases; this decreases the frequency and thus gives a measure of the pressure on the cell.

In Fig. 2, A and B are the coils from a telephone headset. As shown in Fig. 1, these coils are mounted

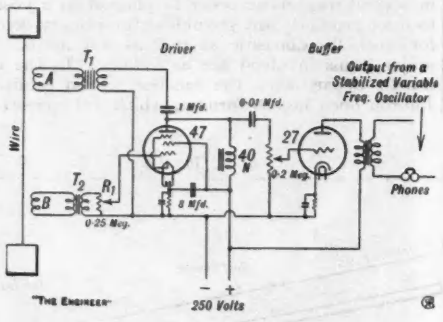


FIG. 2

on the magnets from the headset and these magnets are fixed to the arms which hold the ends of the wire. Thus, there is a magnetic flux passing through each coil, across the gap between the coil and the wire, and along the wire back to the arm. Coils A and B are mounted at right angles so as to prevent mutual coupling between them. The impedances of the coils are matched to the impedances of the driver tube by using suitable transformers T_1 and T_2. A variable resistance R_1 is used to control the amplitude of vibration of the wire. The driver tube is a power amplifier pentode, No. 47. The reason for using this tube is its high amplification factor.

The operation of the driver is as follows:—coil A, the driving coil, causes the wire to vibrate. The wire vibrating in front of coil B varies the magnetic flux through the coil thus inducing a voltage in it the frequency of which is the same as that of the vibrating wire. This voltage is applied to the grid of the tube, which in turn controls the current in the driving coil A. Therefore the wire vibrates at its natural frequency, which depends entirely on the tension, which in turn depends on the pressure on the cell.

The buffer tube, a No. 27, is coupled to the driving tube by a 0·01 mfd. condenser and a 200,000 ohm potentiometer. The purpose of the buffer tube is to prevent any possibility of the oscillator pulling

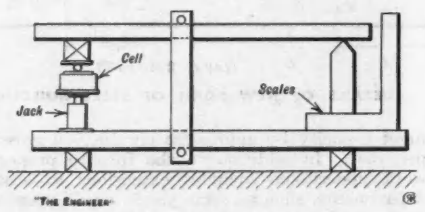


FIG. 3

the wire into synchronism when the frequencies of the oscillator and of the wire are nearly the same.

The output of the buffer tube is connected in series with the output of a variable frequency oscillator and a pair of 'phones. The note heard in the 'phones, when the wire is vibrating and the oscillator operating, is the "beat-note" between the two frequencies. When the frequency of this "beat-note" is zero, then the frequency of the oscillator is the same as the frequency of vibration of the wire. The oscillator used in the preliminary tests was a simple Hartley oscillator, the frequency of which is varied by means of a decade condenser and a continuously variable condenser.

The cell is calibrated as follows:—First the frequency of the oscillator is set at some value near that of the wire by means of a tuning fork. This is done with the condenser readings set at some selected value, and the correct frequency is obtained by varying the coupling between the coils in the oscillator. Periodically this setting should be checked to make sure that the frequency of the oscillator is correct for a particular setting of the condensers. After this check is made, the outputs of the buffer and the 'phones are connected in series with the output of the oscillator. With no load on the cell, the frequency of the oscillator is varied until it is the same as the frequency of the wire, and the condenser readings are taken. A load is now applied to the cell and the operation repeated. The load on the cell is plotted against the condenser readings; this gives a calibration curve. Since the frequency of the oscillator may vary with any voltage variation, a stabilised oscillator would be more satisfactory.

All the equipment shown in Fig. 2, except the wire and coils A and B, which are in the cell, are contained in a steel cabinet, together with a power supply. The four wires from the cell are connected to a four-prong plug which is plugged into a four-prong socket mounted on the cabinet. The oscillator and its power supply are contained in another cabinet equipped with suitable jacks for connecting the two outputs and 'phones in series. The same equipment is used to operate any number of cells, merely by plugging in each one separately.

The mechanical set-up, capable of giving the required load range which was used for calibration is shown in Fig. 3. This simple arrangement is sufficiently indicated to require no written description. In this work care was taken to approach the beat-note always from the same side of the cell note.

Fig. 4 shows a typical calibration curve. For similar initial conditions the curve repeats fairly well. From it, when an unknown load is applied to

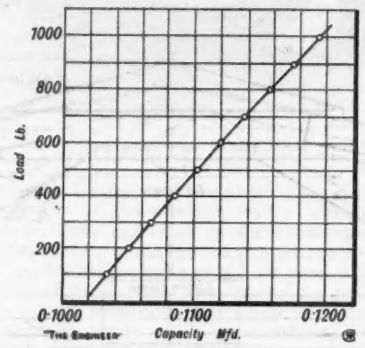


FIG. 4

the cell (the capacity of the condensers having been determined from the readings on the dials) the magnitude of the applied load is at once determined.

The condenser set used in the tests can be improved considerably and will lead to greater accuracy of readings. The cell exhibits remarkable sensitivity, for a change in beat-note due to application of the fingers to the cell can be heard. There is every indication that the accuracy of this cell will be quite satisfactory for the purpose of the measurement of earth pressure and that its rugged construction, as well as its capacity for remaining in working condition over long periods, will make it pre-eminently suitable for that purpose.

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BRITISH STANDARDS INSTITUTION

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

B.S. PLYWOOD FOR AIRCRAFT

(B.S. No. 5V.3).—This is a revised edition of the B.S. Specification 4 V.3. The timber is limited to birch (European or sweet or yellow) and rock maple. Under the provisions relating to the manufacture of the plywood, boards 10in. wide and under must have both faces free from edge joins in the veneers. In the case of wider boards the number of edge joins in the veneers in any ply must not exceed the width of the board divided by 8. The joins must have a stagger of at least 1in. End grain joins in the veneers are not permitted in boards up to and including 60in. in length. Longer boards may have one such join in each face. The joins are to be not less than 12in. from either end of the board and to have a stagger of not less than 12in. End grain joins through the thickness of the boards are not permitted unless specified in the contract, and if so specified they must be scarfed in an approved manner and in the position specified in the contract. The adhesive is to be a paper film glue or other resin glue of approved manufacture. The methods of determining the moisture content, tensile strength, bending properties, adhesion of plies and resistance to water of the finished plywood are fully described.

Copies of this revised British Standard Aircraft Specification (5 V.3) may be had from the British Standards Institution, 28, Victoria Street, London, S.W.1. Price 1s. each (1s. 3d. post free).

GLOSSARY OF HIGHWAY ENGINEERING TERMS

(B.S.S. No. 892—1940). This glossary, which is the result of careful work by a representative Technical Committee extending over several years, is an addition to the series of glossaries of technical terms issued by the British Standards Institution. It is confidently hoped that its publication will lead to a more exact usage of technical terms, and will also enable the student or layman to understand the terminology peculiar to road engineering. Copies of this British Standard, No. 892—1940, may be obtained from the British Standards Institution, 28, Victoria Street, London, S.W.1. Price 5s. each (5s. 5d. post free).

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer.

The American Market

The American iron and steel market so far has shown few signs of the spring revival which it was expected would become apparent in May. The situation in the pig iron section has improved slightly to the extent that some first quarter contracts have been increased by steelworks which buy their pig iron supplies in the open market. The ironfoundries, however, are still for the most part working only four to five days a week. In these circumstances it was decided that the quotations for the second quarter delivery should remain unaltered. These are for No. 3 foundry 23 dols.; for bessemer 23,50 dols. and for basic 22.50 dols. f.o.b. furnaces Pittsburgh, Youngstown and Chicago. It is interesting to note that the quotation for iron ores containing 51·50 per cent. iron content has been reduced 50 c. to 4.45 dols. for delivery at lower Lake ports. The quotation for this grade of ore had remained unaltered at 4.95 dols. for a long period, and it would not be surprising if other grades of iron ore were also reduced in price. It is not expected, however, that the reduction will lead to a decline in pig iron prices. On the other hand, it may check any tendency for the market to advance. It is expected that the ore shipping season will be active and that the movement of ore will total fifty million tons. The scrap market is not firm. The quotation is nominally unchanged at 16 dols. d.d. Eastern and Western Pennsylvania; but it is reported that in some cases the price has been shaded. According to the Institute of Scrap Iron and Steel the consumption of scrap by the steelworks and ironfoundries in March totalled 2,932,000 gross tons, compared with 3,054,000 tons in February. The failure of the output of steel materially to increase in April disappointed the trade. Recently, however, there has been an improvement and the average is now about 66 per cent. of ingot capacity. There is, however, a considerable difference between the various steel producing districts. In Detroit, for instance, the production is 77 per cent. of capacity, in Chicago 62·1 per cent. and in Pittsburgh 56 per cent. The tinplate mills are operating at no more than 64 per cent. of capacity, but this rate is maintained by a steady export trade. Amongst recent contracts is one closed by the Ford Motor Company for 25,000 tons of motor steel, chiefly sheets. The war in Europe has benefitted the United States export trade in steel and there is a steady improvement in the tonnages being sent abroad. At the end of April it was estimated that between 15 per cent. and 20 per cent. of the total sales were for foreign destinations. The invasion of that part of Belgium and Luxembourg in which the iron and steel plants are situated has raised hopes of early substantial purchases in the United States by the Allies.

New Sheet Prices

The Minister of Supply has issued Direction No. 2 dated May 25th, 1940, under the Control of Iron and Steel (No. 8) Order, 1940. The Direction substitutes new schedules of sheet prices for those hitherto ruling, the effect of which is to provide a special price for thick sheets or light plates 3 mm. thick and over when these are rolled on a sheet mill. The demand for this class of material is such that it is necessary to secure production in sheet mills which do not normally roll these thicknesses. In future, the maximum price and extras for sheets or plates 3 mm. thick and over when wholly rolled down in a sheet mill will be the same as for sheets immediately below 3 mm. Other prices, including the price of light plates made on plate mills and prices from merchant's stock for plates and sheets, however made, are unaltered.

The Pig Iron Market

The speed-up in the armament production has thrown an additional strain upon pig iron producers. From the commencement of the war the makers had been concentrating upon the production of steelmaking iron and the output had reached record levels. Imports also had been upon a generous scale, but the invasion of Belgium and Luxembourg will naturally interrupt the flow of supplies from the Continent. Our command of the sea routes, however, will enable us to increase the quantities we obtain from Empire sources and the United States. The production of foundry iron has been upon a scale sufficient to meet requirements, although there has been some stringency in the case of low phosphoric iron. High phosphoric qualities have been freely obtainable, largely because the requirements of the light castings foundries have been comparatively poor. It is expected that the increased armament programme will provide work for a number of foundries which hitherto have not found a place in the war economy. The demand for foundry iron, however, has been slowly expanding for some time and it is possible that recent events may stimulate this movement. The general pig iron situation has been eased to some extent by increased deliveries of scrap and it is anticipated that this process will continue for a time. On the North-East Coast the consumption of foundry iron is at a steady rate and the whole production of this quality which includes special descriptions is small and passes into immediate consumption. Since the beginning of the war local consumers on the North-East Coast have been obliged to use Midland irons which have been taken up in considerable tonnages and more than make good any stringency in the local supplies. The official prices for Cleveland iron rule at 111s. for No. 3 d.d. Teesside and 113s. d.d. in the North-Eastern area, with 5s. per ton loyalty rebate. In the Midlands, although some of the furnaces hitherto producing high phosphoric pig iron have been put on to the manufacture of basic iron, there is no shortage of the former description. Consumers, chiefly the light castings makers, are not working full time although it is expected that more use will be made of their plant in the munitions drive than has hitherto been the case. The engineering foundries however, are taking good supplies of low phosphoric grades. There is a steady demand from the Scottish foundries, although it is from the engineering departments that the call principally comes. The demand for hematite iron is increasing and it is probably in excess of the production. The makers, however, still hold small stocks so that for the present the situation does not cause anxiety. Quotations vary according to district from 127s. 6d. to 139s. d.d. for No. 1 quality.

The Midlands and South Wales

The great activity in the Midland steel industry, which even before the present munitions drive had been extremely busy, has been enhanced by recent events. This country had been receiving supplies of finished steel from Luxembourg and Belgium, and now that practically all these steelworks have passed into German hands the situation naturally causes some anxiety. It is understood, however, that already large orders have been placed with the American steelworks to make up for the loss of these supplies, and no doubt further orders will be placed in Empire countries. The requirements of the structural engineers take up a considerable proportion of the British steel production and continue to expand with the further efforts of the Government to accelerate the munitions output. A large number of factories are being built and the extensions to existing works are another factor which has to be provided for. The production of semi-finished steel is at a high level and all available plant is engaged, and it is in this direction that the contraction in Continental supplies will be most felt. The Continent, however, is not the only source from which this material was obtained and it is practically certain the supplies from other sources will be increased. The demand for shipbuilding steel is extremely heavy and the Admiralty and mercantile programme absorb a large tonnage of steel, although it is probable that there may be some slackening now that the naval position has changed so much in favour of the Allies. Colliery requirements are heavy and the efforts to increase the production of coal must lead to further pressure to obtain arches, props, roofing bars and light rails. The demand is all the greater owing to the cessation of supplies of wooden props from the Baltic. The re-rolling industry in the Midlands has been working recently at top pressure and the works have turned out large quantities of small bars, light sections and strip. Lately there have been considerable imports from the Continent and for the time being the loss of the Belgian and Luxembourg production will not greatly affect the steel situation in the Midlands. By the time recent arrivals have been absorbed it is probable that the arrangements already in hand will have provided material from other sources. In South Wales all the iron and steelworks are operating at as near to capacity as their supplies of raw material will permit. The tinplate makers are in a strong position and still have orders representing over eight million boxes in hand. A steady stream of orders is being received from overseas, and home requirements are on a heavy scale. The ship-repairing yards and dockyards in South Wales are extremely busy and are responsible for the consumption of a large tonnage of steel.

Scotland and the North

The high level of production which the Scottish iron and steelworks have maintained for some months has been improved upon lately as a result of increased supplies of raw materials. The pressure of consumers to secure deliveries is unrelaxed and although the present method of delivery and distribution has relieved the works of a certain amount of responsibility there can be no slackening in the efforts to press forward production. All the Clyde shipyards are fully employed and their requirements amount to a huge tonnage, a considerable proportion of which is on Admiralty account. The big programme of naval and mercantile shipbuilding is being proceeded with at full speed and naturally requires a continuous and heavy supply of steel. The marine engineers also are busy upon engines, boilers, &c. for the new construction. The demands of the constructional engineers have shown no signs of diminishing and they are pressing for large deliveries of angles, joists and sections. Efforts are also being made to manufacture for export and most of the engineering concerns in Scotland are participating in this national movement, although the requirements of the Services have to come first Recently however, the North British Locomotive Company, Ltd. has secured a contract to build ten duplicate locomotive boilers and ten pairs of duplicate cylinders for the Brazilian Great Western Railway. The Scottish re-rollers have been working under great pressure for some months and have been receiving good supplies of semis, of which a large proportion came from Belgium and Luxembourg. Although this source of supply has been cut off by the invasion of the Low Countries it has not yet affected the situation, and it is hoped before the pinch is felt that arrivals from other sources will have made up for the loss of Continental semis. The sheet works in Scotland have been operating under great pressure for months and the requirements of the war departments appear to be increasing. There is also a considerably amount of business passing in sheets for agricultural purposes. The prices for black and galvanised sheets, 24–G basis, are respectively £17 10s. and £20 16s. 3d. d.d. in 4-ton lots. Many of the steelworks and consuming departments are operating on a 24-hour day, and plans are being prepared for the employment of works which have not hitherto been included in the war effort. The constructional engineers in Lancashire are all busy and there has been an increase lately in the demand for colliery steel owing to the effort to increase supplies of coal. A heavy tonnage of forging blooms, billets and rods is passing into consumption and the wire drawers in particular are exceptionally well employed. On the North-West Coast the steelworks are actively engaged. The pressure to secure deliveries of small bars and hoops is particularly strong, whilst all kinds of sections are in great demand.

Copper and Tin

The war situation has not affected the British copper position although naturally the accelerated munitions drive has led to the use of larger quantities. The situation, however, seems to be well in hand and the Control has been able to deliver all the metal required. The advantage of the policy of restricting copper released for commercial purposes can now be seen, and it appears that consumers engaged upon war work have no need to worry about supplies, even if the demand were to expand considerably as it is believed that larger quantities can be obtained from the Empire without any difficulty. There can be no doubt that now and for some time to come the consumption of copper in this country will be at a high level. The situation in the world market has been confused by the invasion of the Low Countries following the occupation of Norway. These markets are of course cut off from any direct sources of supply and in time this may have a weakening effect upon the world position. In the United States the quotation of the primary producers is held at 11.50c. whilst the customs smelters are accepting 11.25c. Little export business has been transacted and the export price is now 11.25c. f.a.s. The American market is quiet and consumers there are not showing much interest in new business. The American statistics show that in April, 68,750 tons were used for manufactured products, and that the industry at the end of the month had unfilled orders for 198,000 tons. Excess stocks of copper held by the manufacturers was 53,000 tons compared with 54,000 tons at the end of March. . . . Tin prices have been fairly steady for the past week, but there is a somewhat nervous undertone in the market. The active buying by the United States has subsided, but it is expected that the American munitions programme will necessitate further large purchases by that Government. The Dutch smelter at Arnhem which is now in German possession has probably ceased operations and is not likely to obtain any further supplies of tin ore. From this point of view the Germans do not appear to have secured any material advantage, but no doubt there was a certain amount of tin in stock in Dutch manufacturers' hands. It is not believed, however, that the quantities secured by the invasion of Holland amount to any considerable tonnage. There could, of course, be an expansion in the production of tin in the East. The news that the tin quota had been raised from 80 per cent. of the standard tonnage to 100 per cent. was well received: but there is a growing feeling that all restrictions upon the output of this metal by the International Tin Committee should be removed.

Lead and Spelter

The lead position has not been greatly affected by the war. So far as Great Britain is concerned the situation is satisfactory, since we can draw from Empire countries larger supplies than we are likely to need. In fact, according to statements made in America, the quantities which the British are using for war purposes are much less than was anticipated. On the other hand, the tonnages of lead obtained by the Germans as a result of their invasion of Holland and Belgium are not likely to be important. In Belgium the stocks are not believed to be large although it is probable that certain accumulations of metal in the form of finished lead products may have been secured. It is now that this country is reaping the benefits of the rigorous contraband control which regulated supplies of lead ores to neutral countries. There has been some expansion in the demand in Great Britain as a result of the fresh pressure for the production of munitions, but no instances are reported of any firm having to go short of material. In the United States the market has been unaffected by developments in Europe and the price has remained unaltered. . . . The greater activity on the production of munitions has led to an expansion in the demand for spelter. The supplies of this metal are entirely adequate to fill requirements and firms have no difficulty in securing their needs. It is probable that the production of spelter in Belgium has come to an abrupt end since the refineries there will be unable to obtain concentrates in future. The acquisition of the Belgian smelting capacity is not likely to benefit Germany for the same reason. It is probable that Germany's spelter production was sufficient for her needs before the invasion, and any advantage she may obtain by her action could only be by producing metal for bartering with countries with which she is still able to maintain trade relations. The French industries consuming spelter may for a time feel the loss of imports from Belgium. It is probable, therefore, that American producers may experience a demand for the metal from the Allies although extensive purchases seem unlikely. The United States market is active and the demand may bring about higher prices. The war news from Europe, however, seems to have adversely affected buying in the United States during the past few days.

LORD NUFFIELD'S LEAD IN WAR EFFORT.—In collaboration with his staff and work people, Lord Nuffield has arranged that in all the factories under his control, not only shall war work proceed seven days a week, but that where material is available overtime shall be worked by both day and night shifts as well. It has also been agreed that the question of any holidays shall be left in abeyance, but that where "Holidays with pay" would normally have been granted, the extra pay under the Nuffield scheme will be forthcoming whether holidays are taken or not.

Regulation of Labour Supply

THE Emergency Powers (Defence) Act, 1940, has vested in the Minister of Labour and National Service the control and use of all labour. The Regulations made under the Act give the Minister power to direct any person in the United Kingdom to perform such services as may be specified by directions issued by or on behalf of the Minister. They also give the Minister power to require persons of any class or description either generally or in any area to register such particulars about themselves as may be necessary, and the further power to enter and inspect premises and require employers to keep and produce such books, accounts and records as may be necessary. In order to give effect to the powers under the Act and to ensure the fullest use of the man-power and woman-power in the country, the Minister of Labour and National Service has established under his own chairmanship a Labour Supply Board on which will serve four Directors of Labour Supply specially appointed for this purpose. They are Major-General K. C. Appleyard, Mr. R. Coppock, Mr. J. C. Little, and Mr. A. P. Young. The Minister intends that the new organisation which is being created to carry out the additional duties and responsibilities imposed on him should work in the closest possible co-operation with the trades unions and employers' organisations, both nationally and locally. It is necessary that detailed questions of labour supply should be dealt with area by area, and the Minister of Labour and National Service has accordingly established a provincial organisation for the purpose. The main machinery will be the employment exchange service directed by the divisional controllers, who will be the Minister's principal representatives in each area. These controllers will in future be Chairmen of the Area Boards which were previously appointed by the Minister of Supply and have now been placed under the general control of the Minister of Labour and National Service. In each important area a local Labour Supply Committee is being established by the Minister of Labour and National Service. It will work in close conjunction with the employment exchange and will consist of a Chief Labour Supply Officer, the Exchange Manager and two other Labour Supply Officers specially appointed for the purpose. The officers will be drawn from persons who have practical working knowledge of industry and industrial conditions. Local panels for particular industries will also be appointed for work in association with these local Labour Supply Committees. The duty of inspecting firms with a view to ensuring that skilled labour is used to the best advantage and that all necessary training facilities are provided will be entrusted to officers to be known as "Inspectors of Labour Supply," who will work in close association with the Area Boards and the Labour Supply Committees. In carrying out his duties under the Emergency Powers (Defence) Act, 1940, the Minister will operate through officers to be known as "National Service Officers" who, together with the existing staff of the employment exchanges, will be empowered on the Minister's behalf to require persons where necessary to undertake work of national importance.

British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

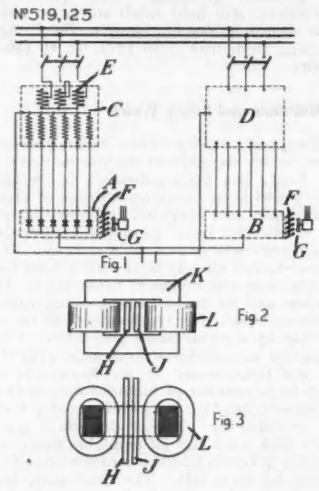
Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

ELECTRICAL APPLIANCES

519,125. September 15th, 1938.—ELECTRIC RECTIFIER ARRANGEMENTS, Patentverwertungs-Gesellschaft mit beschränkter Haftung "Hermes," of Woyrschstrasse 38, Berlin, W.35, Germany.

According to this invention a multi-phase dry metal rectifier arrangement for supplying heavy currents to galvanic or electrolytic baths, in which the current of each phase is distributed between two or more parallel-connected rectifier units or columns, has the parallel-connected rectifier units or columns combined to form two or more multi-phase groups each of which is supplied through a separate transformer. It has been found that, owing to the heavy currents and low voltages, the inductive voltage drops on the alternating current side of rectifiers for supplying electrolytic baths has a disproportionately great effect on the power factor of the entire installation. The inductive voltage drops, particularly in the leads to the rectifiers, may in some cases become as great as the mains voltage. In an arrangement according to the invention not only is the stray inductance of the transformer reduced, but also there is a reduction in the inductance of the leads extending from the transformers to the rectifiers, these inductances being decreased to a fraction of the value they have when a transformer common to the several rectifier units is used. The wattless current taken by the installation is accordingly substantially reduced and the power factor increased. It is furthermore proposed in accordance with a feature of the invention so to arrange the transformers and the associated rectifier units that the lengths of the connecting conductors between them is reduced to a minimum. Fig. 1 is a wiring diagram and Figs. 2 and 3 are respectively elevation and plan views, the plan view being partly in section, of part of the apparatus. The entire rectifier arrangement shown in Fig. 1 is divided into two parallel-connected units A and B which are connected through separate transformers C and D to three-phase supply mains. To produce uniform current distribution between the two units, the primary windings of the two transformers C and D are provided with the tappings E and regulating valves F are provided for controlling the supply of cooling air from fans G so that the amount of cooling air supplied to each rectifier unit can be independently adjusted. The secondary windings of the transformers are connected in six-phase star but they may also, without difficulty, be divided into two three-phase star-connected groups, and the two star points connected together in the known manner through an interphase transformer. However, the increased valve efficiency obtained with the double star connection may also be obtained without employing an interphase transformer by means of

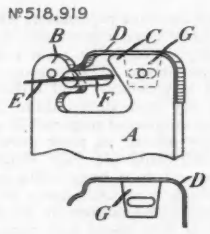


transformers constructed in the manner shown in side elevation in Fig. 2 and in plan in Fig. 3. The transformer consists in this case of three single-phase transformer units having secondary windings formed by bars H, J. These bars are surrounded by an iron core K, which carries two series-connected primary windings L. Each of the bars acts as a secondary winding to supply one phase of the six-phase system, the bars preferably being combined to form a six-phase star system. With this arrangement the current carrying periods of the individual valves amounts not to 60 electrical degrees but to 120 electrical degrees as in the case of a circuit arrangement containing an interphase transformer, because the magnetic circuits of the individual primary phase windings are not interlinked.—*March 18th*, 1940.

MEASURING AND TESTING INSTRUMENTS

518,919. July 7th, 1938.—ELECTRIC MEASURING AND/OR INDICATING INSTRUMENTS, the General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.2, and Harold Wilkinson Morris and Henry Cobden Turner, both of Salford Electrical Instruments, Ltd., Peel Works, Silk Street, Salford, Lancashire.

This invention applies to photo-electric exposure meters in which the indicating part of the instrument is of the moving coil type. If such an instrument is adapted to give reasonable deflections for small light values, the deflection when the meter is exposed to brilliant sunshine is excessive. The object of the invention is to provide an instrument which will not be open to this objection. According to the invention, an extension piece of magnetic material is provided on one pole piece of the instrument magnet, the extension piece being arranged to produce a counter torque in the moving coil when the moving coil approaches a position corresponding to a



maximum reading of the instrument. Preferably the extension piece is adjustable whereby the counter torque may be adjusted. The movement is adapted to operate with a logarithmic characteristic and comprises a permanent magnet A with pole pieces B and C shaped to give the desired characteristic. On one pole piece C is mounted an extension piece D in the form of a thin iron strip bent to conform roughly with the tip of the pole piece and extending over the axis E of the coil F so as to provide a certain degree of reverse flux. The extension piece D is secured to the pole piece by a screw passing into the side of the pole piece through the slot in a flange G on the extension piece. The provision of the slot in the fixing arrangement permits of a certain amount of adjustment of the position of the extension piece, so that the counter torque in the moving coil produced by the reverse flux may be adjusted. In this particular arrangement the instrument may be made sensitive for low light intensities and then in order to bring the pointer on to the scale for large light intensities, as in brilliant sunshine, the extension piece is suitably adjusted.—*March 12th*, 1940.

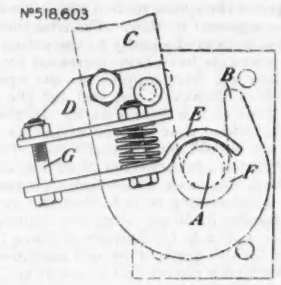
MISCELLANEOUS

518,460. October 3rd, 1938.—IMPROVEMENTS IN AND RELATING TO ELASTIC JOINT PACKINGS, Ural-Maschinen-Vertriebsgesellschaft, m.b.H., a German Company, of 13, Walfischgasse, Vienna 1, Germany.

Packings between the adjacent ends of two parts which under the influence of heat expand in service so that the gap between these parts varies in size often fail to return to their initial shape when the parts cool, and become permanently set. According to the invention this is avoided by using for the packing a ring formed of a strip of elastic steel or the like having in cross-section the shape of an inclined, elongated S, sprung between the joint faces so that its rim surfaces, in planes parallel with each other, bear on the faces under stress. With a thin strip of metal used for making the ring, for example, spring steel, the contact area is small, but contact is made with relatively high specific pressure, and a comparatively large expansion can, it is claimed, take place without so tilting the rim surfaces of the ring that leakage is liable to occur.—*February 27th*, 1940.

518,603. October 19th, 1938.—IMPROVEMENTS IN SKIPS OR BUCKETS OF ROPEWAY SYSTEMS, ETC. Joseph Walwyn White and Christopher Olai Valberg, both of R. White and Sons, Railway Engineering Works, Widnes, Lancaster.

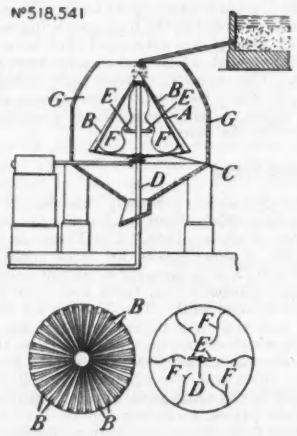
In aerial ropeway or telpher systems it is usual to mount a bucket, by way of example, on trunnions, and this type of mounting has the disadvantage that the bucket is apt to oscillate about the axis of the trunnions when tipping its contents, and this oscillation persists during the travel of the bucket. According to the present invention damping means are interposed between a bucket and its supporting hanger in order that any oscillation is rapidly suppressed. The bucket



is suspended by means of trunnions A on the open hook ends B of hangers C. These hangers have a bracket D attached to them carrying a pair of bolts forming guides for a strap E adapted to partially encircle an eccentric cam F on the trunnion. The strap can be deflected against a compression spring around one of the bolts. When the bucket is in an upright position the under side of the curved end portion of the strap is practically clear of the eccentric, but as soon as the bucket is tipped over and completely reversed the crown of the cam engages fully against the strap, thus damping or preventing swinging. The degree of frictional engagement or damping can be controlled by adjustment of the bolt G.—*March 1st*, 1940.

518,541. August 25th, 1938.—TREATMENT OF SLAG FROM BLAST AND REDUCTION FURNACES, Holland and Hannen and Cubitts, Ltd., 1, Queen Anne's Gate, London, S.W.1, and Dr. Hans Kohl v. Asboth, Haus Weidmannslust, Plainbrüche, Salzburg, Germany.

In the use of the apparatus illustrated the molten slag is led from the furnace by way of a trough to pour on to the apex of a conical hollow body A. A number of rows of holes run from the apex to the lower edge of the cone. Each row of holes lies on the deepest line of a channel, which is bounded on both sides by two ribs B B of triangular cross section. Furrows are thus formed which are substantially flat at the apex of the body and get deeper as the lower edge is approached. The



cone is closed at the bottom by a lid C. The body rotates rapidly about a hollow shaft D when water, steam, compressed air, or inert gas streams out of lateral openings in this shaft, or as shown, through spray-nozzles E, and impinges upon blades F on the inside of the body. The impinging stream causes the body to rotate rapidly about its hollow shaft, and cannot escape from the body except by way of the holes therein, over which the molten slag flows down in the channels. The slag is thereby foamed and loosened from the wall and the foam slag, which is gradually hardening in the porous state, is finally thrown against a wall G by the centrifugal force, which increases as the slag approaches the lower edge of the body. The particles fall in granulated form and after cooling may then be used.—*February 29th*, 1940.

PERSONAL AND BUSINESS ANNOUNCEMENTS

BRUSH COACHWORK, Ltd., informs us that Mr. L. G. Reid, General Manager of Brush Electrical Engineering Company, Ltd., has been appointed to the Board of Brush Coachwork, Ltd.

J. H. FENNER AND CO., Ltd., announce that they have appointed Norman Bell and Co. (Pty.), Ltd., Electrical and Mechanical Engineers of Brisbane, as their agents in Queensland, Australia.

CATALOGUES

GENT AND CO., Ltd., Faraday Works, Leicester.—A new catalogue on electric bracket and turret clocks.

BRITISH THOMSON-HOUSTON COMPANY, Ltd., Rugby.—Brochure on "BTH" electrical and mechanical equipment for marine service.

STEATITE AND PORCELAIN PRODUCTS, Ltd., Stourport-on-Severn, Worcs.—A catalogue dealing in considerable detail with pedestal and cylindrical post insulators.

STANELCO PRODUCTS, Ferndown, Northwood Hills, Northwood, Middx.—Particulars of the electrode soldering equipment and portable electric tools made by the firm.

J. W. and C. J. PHILLIPS, Ltd., Pomeroy Street, London, S.E.14.—Loose leaf catalogue covering the extensive range of engineers' pattern shop equipment made by the firm.

WESTINGHOUSE BRAKE AND SAXBY SIGNAL COMPANY, Ltd., 82, York Way, London, N.1.—A booklet entitled "Resignalling of Victoria Station and Approach Lines, Southern Railway."